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Evaluation of Chiller Plant Energy Conservation Opportunities at Fort Hood, Texas

by
Gerald L. Cler, Alan T. Chalifoux, Kim Parson, and Bruce Higgs

Chiller plant owning and operating costs represent substantial investments at Fort Hood, Texas. Primary objectives of this work are to evaluate the performance of major plants and associated distribution systems, and to identify relevant energy conservation opportunities (ECOs).

Significant effort was expended to gather information and document the performance of plant cooling equipment. Data were obtained from site surveys, discussions with vendors and manufacturers, and reviews of previous studies. Performance was documented with field measurements. Subsequent analyses of ECOs were performed with simplified bin methods consistent with first-order conclusions and recommendations required from this work.

Results for all ECOs were heavily influenced by the utility rate structure. At Fort Hood, 75 percent of annual chiller energy cost is determined by demand charges. Alternatives for chiller ECOs were also limited by the effects of recent regulations that govern the use of refrigerants. Therefore, realistic improvements that reduce chiller energy consumption necessarily involve replacement or major upgrade of most chillers. Other potential ECOs targeted reductions in chiller and pump energy by modulating speed in relation to cooling load. A select group of chillers will benefit from this technology. The higher capital costs combined with the unusually low energy charge preclude speed modulation for all other motors.

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Foreword

This study was conducted for Headquarters, U.S. Army III Corps and Fort Hood with funding by the Strategic Environmental Research and Development Program (SERDP) through the U.S. Army Model Energy Installation Program (MEIP); Thrust Area II, "Central Utility Systems"; Work Element 23, "Central Utility Systems–Cooling." Public Law 101-510 established SERDP as a multiagency program funded through the Department of Defense (DOD) to identify, develop, and demonstrate technologies in the areas of pollution prevention and cleanup, energy and resource conservation and global environmental change. SERDP responds to the environmental requirements of DOD and is undertaken in cooperation with other government agencies, including the Department of Energy, the National Institute of Science and Technology (NIST), the National Oceanographic and Atmospheric Administration, the U.S. Geological Survey, and the National Aeronautics and Space Administration. Bobby Lynn, AFZF-DE-ENV, is the technical monitor; Dr. John Harrison is Director, SERDP.

The work was performed by the Engineering Division (FL-E) of the Facilities Technology Laboratory (FL), U.S. Army Construction Engineering Research Laboratories (USACERL). The Principal Investigator was Gerald L. Cler. A portion of this work was performed on contract by Bruce Higgs of Wieland, Lindgren and Associates, Inc., Seattle, WA. Larry M. Windingland is Acting Chief, CECER-FL-E, and Donald F. Fournier is Acting Operations Chief, CECER-FL. The USACERL technical editor was Agnes E. Dillon, Technical Resources.

Dr. Michael J. O'Connor is the Director of USACERL.

Contents

1 Introduction

Background

Work under this contract was performed as part of the Model Energy Installation Program (MEIP) directed by the U.S. Army Construction Engineering Research Laboratories (USACERL). This 5-year plan was developed to demonstrate the feasibility of large-scale energy reduction programs. Identification of chiller plant energy conservation opportunities (ECOs) was only one aspect of the basewide investigation of possible energy efficiency retrofit opportunities.

Energy conservation opportunities at Fort Hood, Texas, have been evaluated in two known projects within the last 15 years[1,2]. Large scale implementation of ECOs recommended by those reports[1,2] was not readily apparent during site investigations. This statement is particularly true for the latter study, which was reviewed early in this project.

Recently adopted regulations governing the use of refrigerants ultimately will create conditions that will force owners of equipment to switch to a chlorofluorocarbon-free (CFC) refrigerant. Many traditional refrigerants are affected by these regulations, and suppliers are ceasing production of CFC refrigerants (see Chapter 3 and Appendix A).

Objectives

This project had three objectives:

- identify ECOs that will reduce energy cost and consumption by 30 percent annually
- identify technologies that will significantly reduce the environmental impact of facility energy operations
- document analysis techniques and methodologies that could serve as a prototype approach for Army-wide application.

Approach

Objectives were accomplished with a combination of site observations and engineering analyses. The initial phase of work, which was oriented toward gathering information, included field surveys to obtain nameplate data and measure performance parameters. Subsequent follow-up contacts with appropriate manufacturers (Appendix B) were necessary to obtain equipment specifications. Most of this information, which included original sales orders and/or catalog cuts, was retrieved from the manufacturers' archives, a procedure that was surprisingly successful, but lengthy. The best available record drawings for mechanical systems were furnished to USACERL from archives at Fort Hood. This process was relatively successful in terms of obtaining drawings for most plants. Some drawings did not reflect remodeling work that took place after initial construction; this was discovered during site observations.

Later phases of work involved documentation and analyses of field measurements and modeling of potential ECOs (see Appendixes A through N). Some manual effort, such as plotting existing pump operating points, was involved. However, due to the wealth of information that could influence conclusions and recommendations, the majority of analyses and modeling were performed with a spreadsheet application specifically developed for this project. Field-measured data were used as input for this part of the work where such data were judged to be valid. Otherwise, typical values obtained from other sources, such as industry publications, were input to proceed with the work. Instances where assumptions or theoretical data may have significant impact are noted. A final scheduled trip that focused on maintenance procedures also occurred midway through this final phase of work.

Scope

Four significant limitations on the scope of this work must be considered. The ECOs that may be available beyond central plant boundaries were excluded from the scope of this study. If such opportunities were observed during site visits, they are noted in text, but were not acted on. Similarly, analyses of the interdependency of ECOs developed during this project will not be performed as part of this project.

Data necessary to establish baseline energy consumption per plant is nonexistent. The best available metering that would include chiller plant loads is located at three substations (one serving Main Fort Hood, one serving West Fort Hood, and one serving North Fort Hood) which serve the entire fort (population 60,000 plus) (Jeff Morton, Robert Nemeth, Jerry Reed, and Bruce Rives, Principal Investigators, U.S.

Army Construction Engineering Research Laboratories, Champaign, IL, professional discussion, 1992 [hereafter referred to as Morton et al. 1992]). Such baseline data would be useful to confirm the absolute accuracy of plant energy consumption simulations contained herein; it would be invaluable to prove or dispute actual energy savings after ECOs are implemented. For large plants that serve housing complexes, this difficulty is compounded by the absence of documented operating parameters, such as fluctuations in local housing populations that occurred during Operation Desert Storm. These fluctuations will continue and become more accentuated as a result of upcoming base closures. Fort Hood will likely absorb a portion of these displaced military personnel, which will obviously impact energy consumption. To help resolve some of these difficulties in electrical consumption and cooling loads, USACERL (in another phase of the MEIP) began to apply the energy disaggragation algorithm (EDA) methodology to determine loads for specific buildings and to disaggregate total energy use into its component end uses.

A part of the work was intended to discover gross savings opportunities using quick and simplified methods. This necessarily implies that special cases could not receive the attention which would be warranted if each case were the only case under consideration. It also implies that, in some cases, engineering judgment may be exercised with greater latitude than detailed research would permit, and that abbreviated calculations would be acceptable in lieu of exhaustive documentation. The intent of the MEIP was to identify, scope, and implement projects within 5 years. Detailed research requires data. As outlined here, detailed data were not available. Generating data takes time. Exercising engineering judgment was the necessary bridge required to get from analyses to project implementation within 5 years.

Unique characteristics of this site must be considered when results presented herein are applied to other locations. The utility rate structure is a prime example. At Fort Hood it is difficult to justify ECOs that reduce energy consumption, without reducing peak demand, because the utility charge for energy consumption represents only 25 percent of the total cost for electricity. An ECO that reduces energy consumption by 33 percent, for example, will reduce energy cost by only 8 percent if peak demand remains unchanged. Weather, operating schedules, and local construction costs are other obvious parameters that will affect ECO payback periods at other sites.

Unrelated to identification of ECOs are issues concerning code violations and unsafe operating conditions. No attempt was made to identify, investigate, or extensively document any code violations.

Mode of Technology Transfer

The findings in this study will support ongoing energy systems modernization research. The results of this study were used to apply for funding to implement the ECOs described herein. The results also will be used to update energy users, particularly at Fort Hood (e.g., they were communicated to Fort Hood maintenance personnel), on an evaluation technique for chiller plants, serve as a baseline document for chillers at Fort Hood, and provide an analysis of chiller plant ECOs at Fort Hood.

Metric Conversion Factors

U.S. standard units of measure are used throughout this report. Conversion factors for standard international (metric) units are provided here.

1 in.	=	25.4 mm
1 ft	=	0.305 m
1 yd	=	0.9144 m
1 cu in.	=	16.39 cm^3
1 cu ft	=	0.028 m^3
1 sq ft	=	0.093 m^2
1 sq in.	=	6.452 cm^2
1 ton	=	907.1848 kg
1 lb	=	0.453 kg
1 lb/hr	=	0.126 g/s
1 psi	=	89.3 g/cm^2
1 psi	=	6.89 kPa
1 torr	=	133.322 Pa
1 rpm	=	6.0 degrees/sec
1 gal	=	3.78 L
1 gpm	=	0.06308 L/sec
°F	=	(°C + 17.78)*1.8
3412 Btu	=	1 kWh
1 hp	=	.7457 kW

2 Documentation and Analysis of Existing Conditions

Equipment Specifications and Field Measurements

Central chiller plants selected for examination in this study are the same 33 plants examined by Romine, Romine & Burgess, Inc.[2] in the late 1980s. Table C1 (Appendix C "Chiller Plants and Buildings Served"), documents this information. Trip notes at the end of Table C1 explain field observations that reduced the scope of this project to 29 plants that contain 44 chillers and serve approximately 117 buildings, most of which are located in the central area of the installation.

Tables D1 through D4 (Appendix D) list nameplate and field measurement data for chillers, cooling towers, chilled water pumps, and condenser water pumps, respectively. Table D2, "Chiller Reference Data From EEAP Report," includes pertinent data from the EEAP study[2] that was used to validate and supplement performance data derived by alternate methods in this study. Comparison of nameplate data included in Tables D1 and D2 indicate that 38 chillers are common to both studies, 3 chillers have been replaced since the EEAP study[2], and 3 chillers discussed in this report were not included in the EEAP study[2]. This comparison is included on page 2 of Table D1 (Appendix D) under the column titled EXIST vs 88/89. The most important information obtained from the EEAP study[2] was a simulated cooling load for each plant.

Instrumentation for field measurements included a thermocouple-type thermometer for dry-bulb and water (nonintrusive) temperatures, a sling psychrometer for wet-bulb temperatures, a magnehelic gauge for differential air pressures, several water pressure gauges with ranges from compound to 100 psig for differential water pressures, and a clamp-on volt-ammeter with adjustable ranges. Existing gauges either were not used (most did not work properly) or were temporarily removed, if possible, for access to gauge tappings. The only exceptions were factory-mounted refrigerant temperature and pressure gauges and digital read-outs in chiller control panels equipped with such capability. Differential water pressure was measured with a common gauge, where possible, either mounted in a portable manifold or mounted separately for each measurement. Additional measurements were obtained with a

vibration analyzer and a power/demand analyzer for a select group of chillers during the maintenance observation trip. In addition, the visual condition of most equipment was documented with photographs.

The instrumentation was accompanied by an assortment of basic tools and a complement of spare parts, including gauge cocks, pipe nipples, adapters, etc. Primary obstacles to obtaining necessary measurements were either corroded or mislocated gauge tappings, or there was a complete absence of such ports. Measurement work was temporarily interrupted on numerous occasions to clear plugged ports and, in a few instances, to perform emergency repairs on corroded nipples that disintegrated when wrenches were applied.

Central Plant Performance

The goal of field measurement procedures was to obtain information sufficient to derive chiller outputs (tons) and efficiencies (kW/ton) at known times and ambient temperatures. This information could be used to identify oversized/undersized equipment and establish baselines from which realistic energy savings could be estimated.

Efforts geared toward calculation of actual chiller outputs and efficiencies were not as successful as hoped for. Failure can be attributed to the inaccuracies involved in deriving water flows from pump curves using measured pressure differentials, and using impeller sizes determined from specified operating conditions. This difficulty became apparent when heat rejection ratios calculated for a large number of chillers (heat rejected by condenser divided by heat absorbed by evaporator) significantly exceeded the normal range of 1.2 to 1.3 for typical chillers. Heat ratios are calculated with flow and temperature values. Because values obtained from temperature measurements are relatively error-free, derived flow values were judged to be incorrect.

Combinations of several factors contributed to this problem. Minor inaccuracies are inherent in gauge readings. Mislocated gauge tappings (for example, on the upstream side of strainers) have a similar but more pronounced effect. Pressure readings obtained from tappings on pump flanges also are subject to errors created by nonuniform flow at these locations and, in fact, are not used by manufacturers to rate pump performance. The most significant problem with applying measured pressure differentials to pump curves is that all of the measurement inaccuracies become magnified on pump curves with shallow slopes. The size of most pump impellers in this study was determined from pump curves by plotting specified flow

and head. This method may not accurately predict impeller size for several reasons. One pump manufacturer may trim an impeller to this exact size; another may trim to the next largest undocumented increment of 1/10 in. or 1/8 in. If rush delivery during construction was a consideration, a stock pump, whose impeller size was "close enough," could have been installed. Less common are the possibilities that an impeller was trimmed to a different operating point as part of balancing work, or that the original impeller was replaced for maintenance reasons. Because impeller size is critical in determining flow from measurement of differential pressure, an inaccurate determination of impeller size leads to an inaccurate determination of flow. This difficulty can be overcome, to a large extent, by obtaining a differential pressure measurement at pump shut-off (no-flow). However, this test cannot be performed without disrupting operation of the chillers, and such disruptions were prohibited during the site visits.

Inspection of heat rejection ratios calculated from measured flows and temperatures documented in the EEAP report[2] indicates that their method of determining flows appears to have been much more successful. Flows in that study[2] were measured directly by a clamp-on type ultrasonic flow meter. Although proper performance of this device is subject to its own limitations, such as sufficient lengths of straight pipe, this device eliminates all of the difficulties described in the preceding paragraph.

A graphical comparison of flows determined by an ultrasonic meter (EEAP study[2]) and flows determined by plotting measured pump differential and impeller size (this study) is illustrated by Figures E1 and E2 (Appendix E) for evaporator and condenser water circuits, respectively. In these figures, flows determined in the EEAP study[2] are labeled "MEASURED," and flows determined in this study are labeled "DERIVED." Plotted points represent the ratio of flow determined by each method, measured or derived, divided by the design flow for that pumping circuit. Design flows were obtained from pump nameplates when possible, or from pump schedules on construction documents. The left-hand portion of both plots may be disregarded (for comparison purposes) because flows from both methods were not available for comparison. Values on the right-hand portion were plotted with ratios for EEAP flows sorted in ascending order for optimum viewing. In addition to the widespread flow problems suggested by EEAP measurements (flow in 76 percent of the circuits falls above or below design value plus/minus 10 percent), these graphs summarize pitfalls of the pump curve approach. Lack of one key piece of information, such as a measured pressure or pump curve, halts the analysis procedure (as far as determining actual load and efficiency) for that entire plant. This occurred in nearly three-quarters of the plants in this study, with condenser flows being the prime offender. Again, this was due to the lack of pressure taps, plugged ports, etc.

The end result of this entire exercise is that actual values for chiller output and efficiency could not be derived from field measurements because the methodology could not account for all potential variables and errors. Therefore, substitute values were used to allow work to proceed. Sources of these substitute values are discussed in Chapter 3 under "Operating Parameters." A revised approach for accomplishing stated objectives in future energy conservation studies is discussed in Chapter 9, Conclusions and Recommendations.

3 Energy Conservation and Economic Considerations

CFC Refrigerant Issues

The impact of recently adopted regulations that govern the use and handling of refrigerants is just beginning to be realized by the majority of chiller owners and operators. Although these regulations allow continued use of existing equipment that operates with an "unfriendly" refrigerant, they ultimately will create market conditions which will force owners to switch to equipment that operates with a CFC-free refrigerant. Tight market conditions are already noticeable, and they will worsen within the next year. Dupont, the largest supplier of unfriendly refrigerants, ceased production of these materials in 1994, and all other production ended by January 1995. Appendix A is a summary of information currently available on CFC refrigerant issues. However, owners should note that new information is issued regularly as the industry reacts, and some manufacturers have been criticized by peers and professional organizations for distributing inaccurate information.

Installation of the first set of R-123 based chillers at Fort Hood was nearly complete in Building 10006 at the time of the first site visit. Consequently, Building 10006 was removed from the scope of this study. Major renovation of nearby Building 9418 also is underway, although the type of chillers planned for this complex is unknown.

A quick review of Table D1 (Appendix D) indicates that 35 of the 44 chillers included in this study operate with three undesirable refrigerants: R-11, R-113, and R-12. It would be unwise and illogical to recommend ECOs for all of these machines to improve performance, and possibly extend their useful life, but retain present refrigerants. The preferred approach would be development of ECOs that allow phased replacement or upgrade of chillers to accomplish both energy- and refrigerant-related objectives. Therefore, a portion of the resources allotted for this study was devoted toward addressing refrigerant concerns. The alternative of replacing most chillers is evaluated in Chapter 5 as ECO-1. Options for conversion or retrofit of existing chillers are discussed separately in Chapter 6. The preferred combination of all alternatives, which is the equivalent of a base master plan for upgrading chiller plants, is discussed in Chapter 9.

Operating Parameters

Design cooling load is a major variable whose value can be obtained from a variety of sources. As discussed in the preceding chapter, actual values for this variable could not be obtained by field measurements in this study due to limitations in the methodology used to derive chilled and condenser water flows. Therefore, another source was consulted, namely the EEAP report[2].

The EEAP report[2] documents two potential sources for design cooling loads. One set of loads for almost all plants was available directly from engineering load calculations prepared for buildings served by the plants. Load calculations in the EEAP study[2] were performed by computer using the "Hourly Analysis Program" (HAP) published by Carrier Corp. This software package is a nationally recognized leader in the industry. Cooling loads (for each plant) obtained by this method are listed on page 1 of Table D2 (Appendix D) for each plant. A second set of design cooling loads can be determined from field measurements of chilled water flow and differential temperature listed in the EEAP report[2]. With measured cooling loads and coincident outside air temperatures from the EEAP study[2], and profiles of percent full load versus outside air temperature developed in this study, design cooling loads can be determined by extrapolation. Because coincident temperatures were no less than 84 °F, and generally greater than 90 °F, measured cooling loads within this range of outside air temperatures can be extrapolated to design cooling loads at 99 °F outside air temperature with reasonable confidence. Figure E3 (Appendix E) is a graphical comparison of design cooling loads obtained by both the HAP simulation ("H.A.P. CALC") and extrapolation ("PROJECTED") methods. After some debate, HAP loads were chosen as input for this study, primarily because conditions that would qualify the use of measured loads to predict design loads were unknown. For example, if the status of people and lighting loads at the time of field measurements had been confirmed in the EEAP study[2] to reflect design conditions, extrapolated loads may have been chosen over HAP loads in this study. The difference between loads determined by two methods for each plant translates directly into reduced payback periods because less capital cost is expended for smaller central plant equipment.

Annual hours of operation for each plant are tabulated on page 1 of Table D1 (Appendix D). Based on review of chiller log books, plants are scheduled to operate either year-around or only during the 6-month cooling season. Plants that operate year-around include two training flight simulator buildings, the main hospital, the dental clinic, the commissary, and the post exchange retail store.

Annual load profile quantifies the variation in plant cooling load during scheduled hours of operation for 1 year, i.e., the number of hours per year that a plant will

operate at incremental steps of total capacity. Appendix F outlines the derivation of a profile for a typical barracks building. Plots of annual load profiles normally resemble bell-shaped curves, as shown in Figure F5 (Appendix F). Contours of such profiles are influenced by weather patterns, types of buildings, operating schedules, and all other variables that determine cooling load. The profile shown in Figure F5 (Appendix F) was used for all plants in this study because barracks buildings are the predominant type of connected load.

As is true of the design cooling load, the full load efficiency of existing chillers is another significant variable whose values had to be obtained from alternate sources. In this study, calculations of energy consumption for existing chillers are based on full load efficiencies quoted at the time of purchase. These values are shown in Table D1 (Appendix D). Efficiencies with the suffix "E" denote estimated values that were used because manufacturer's quoted efficiencies were not available.

Using nameplate efficiencies, rather than current operating efficiencies, obviously neglects deterioration due to age and poor maintenance. An example of deterioration in chiller efficiency is discussed in the *ASHRAE Handbook of Heating, Ventilating, and Air-Conditioning Systems and Equipment*[3]. Chapter 36 of this handbook[3] describes the penalties imposed by excess fouling. For the condenser cited on page 36.7 of this handbook[3], fouling sufficient to raise the saturated condensing temperature by 5 °F will increase compressor power by 5 percent and decrease chiller capacity by 3 percent, for a net reduction in chiller efficiency of more than 8 percent. Similar reductions in efficiency are caused by the presence of noncondensable gases in low-pressure (R-11 or R-113) machines. Thus, if actual chiller efficiencies for poorly maintained equipment could have been documented by field measurements, shorter payback periods could have been substantiated by the excess energy consumed by such machines. However, nameplate efficiencies were the best available information that would allow the study to proceed within the time allotted. This approach accomplished the stated objective of identifying cost-effective ECOs. Note that this method erred on the conservative side and did not result in inflated estimations of payback periods.

The full load efficiency of replacement chillers investigated in ECO-1 is listed in Table I8 (Appendix I). Efficiencies for specific chiller sizes required in this ECO are interpolated from quotes of efficiencies for standard chiller sizes listed in Table G1 and shown in Figure G2 (Appendix G). The installed cost for specific sizes of replacement chillers was interpolated from data listed in Table G1 and shown in Figure G1 (Appendix G).

Central plant controls are essentially manual except for standard unloading capabilities normally furnished with chillers and fan cycling and/or bypass controls

installed for cooling towers, many of which were disconnected. Evidence that chilled water or condenser water reset is employed in control sequences was not readily apparent. Because chiller simulations for both existing and proposed machines assume condenser water reset is employed, energy consumption for existing conditions is likely to be underestimated. Also, none of the plants are equipped with variable speed controllers for chillers or chilled water pumping circuits. Therefore, computer modeling of chiller operation for existing conditions was relatively straightforward and could be accomplished with sufficient accuracy using bin-method techniques.

Utility Rate Structure and Incentive Programs

At the time of this study, the vast majority of Fort Hood property was served by Texas Utilities Electric Company under rate schedule GP, General Service Primary. This schedule incorporates standard charges along with clauses that are negotiated on a periodic basis. USACERL analyzed current and proposed rate agreements and determined the unit cost of energy and demand, including the ratchet clause[3]. This information is shown in Table 1.

Table 1. Utility Charges.

Electric	Charge
Energy	\$0.024/kWh
Demand	\$152.60/kW-yr

This utility offered a variety of demand side management (DSM) incentive programs designed to encourage reduced customer demand and consumption[4]. Of primary interest are rebate incentives for chillers and high-efficiency motors, both of which are offered for new and retrofit applications under the On-Peak Efficiency Improvement Program.

Chiller rebates are offered in tiers based on the type and output rating of the machine. Criteria for chillers of interest in this study are shown in Table 2. Rebates are paid at the rate of \$100/kW reduction (below the base efficiency) for units that exceed the base efficiency, or \$150/kW reduction (below the base efficiency) for units that exceed the bonus efficiency. For a 500-ton, water-cooled, centrifugal machine with a full load efficiency of 0.60 kW/ton, the rebate would be:

500 tons*[(0.80-0.70)kW/ton*\$100/kW + (0.70-0.60)kW/ton*\$150/kW] = \$12,500

Table 2. Chiller Utility Rebate Criteria.

Chiller Type	Capacity (tons)	Bonus Efficiency (kW/ton)	Base Efficiency (kW/ton)
Water-cooled Reciprocating	10-100	0.90	1.00
	101+	0.85	0.95
Water-cooled Centrifugal	101+	0.70	0.80
Water-cooled Screw	10+	0.70	0.80

A similar tiered approach is offered for high- and premium-efficiency motors rated at 3 hp and larger, whereby a base payment of $100/kW reduction is offered for motors that exceed a minimum standard efficiency, and a bonus payment of $2.00/hp is offered for motors that exceed a minimum premium efficiency. For motors rated at 300 hp and larger, base payments are limited to retrofit applications only, and bonus payments are not offered. Target efficiencies for base and bonus payments vary according to the size of the motor, and they may be obtained from the utility. Potential rebates available under ECO-4 are listed in Tables L1 and L-2 (Appendix L), ECO-4 calculation of simple payback periods, sorted by pump number and plant number, respectively.

Construction Costs

Estimates of construction costs are included in the appropriate attachment for each ECO. Costs are summarized in the respective table(s) in Appendix I that documents simple payback periods. Cost breakdowns are included in separate tables (see Appendix I) for significant conservation opportunities such as ECO-1.

Cost estimates are based on budgetary-type quotes from equipment vendors for items such as chillers and cooling towers, and generic values obtained from established estimating publications[5,6,7]. Values from latter sources are adjusted to reflect local market conditions for material and labor as recommended in the publications[5,6,7]. The estimates were prepared with an abbreviated take-off approach (as is typical of engineering cost estimates) and include contingencies from 10 to 20 percent to account for small costs that cannot be itemized at this time. No overall safety or escalation factors have been applied, nor have design fees or similar soft costs. Costs do not reflect quantity discounts that may be available if upgrades to several plants are combined into one construction project. Columns for total cost do not include credits for utility rebates. The effect of rebates is reflected only in calculation of simple payback periods, i.e., [total cost - rebate]/savings = simple payback.

Costs included for ECO-1 were prepared with standard subassemblies for chillers, cooling towers, and pumps. Chiller assembly costs, for example, include a standard allowance of 20 ft of piping, two valves, two flexible connections, etc. for each water circuit.

Costs for additional materials required for unusual conditions were calculated separately. This method allowed extra costs to be categorized as to should they be included in net payback calculations or only in total project cost. Costs to upgrade mechanical rooms for compliance with refrigerant regulations is one example in which costs are excluded from net payback calculations. If water-cooled chillers are recommended to replace air-cooled machines (for improved efficiency), extra costs associated with the cooling tower and condenser water pump are deemed appropriate for inclusion into net payback calculations. However, if existing towers and pumps must be replaced because existing equipment appears to be undersized or in extremely poor condition, associated costs are included only in gross calculations.

4 Methodology for Simulation of Chiller Operation

Overview

Material in this chapter is included as a focused response toward objective three, to assist in development of a prototype approach for Army-wide application. Readers may bypass this chapter if they are interested only in discussions that relate to specific ECOs at Fort Hood. Additional material that could be used to enhance the approach for future studies is inherently contained in other discussions throughout this report.

Software modules that simulate annual operation of chiller plants to predict energy consumption are available as supplements to most load calculation software packages. The primary difficulty in applying such software to a project of this nature is that resources expended to perform the simulations are inconsistent with the order of magnitude required from the output. Therefore, the spreadsheet template documented in Appendix H was created.

The original version of this chiller simulation spreadsheet template was developed in conjunction with Table G4 (Appendix G), "Payback Comparison of Reciprocating vs. Centrifugal Water Cooled Chillers," which verified the optimum changeover tonnage from reciprocating to centrifugal water-cooled chillers. Revision 1 of this template incorporated algorithms to model a variety of multiple chiller arrangements and was used to create the original version of Tables I1 and I2 (Appendix I). Revision 2, which is documented herein, includes enhancements such as demand-limiting. It was used to update Tables I1 and I2 and to create Table I3 (Appendix I).

Input for Multiple Simulations at One Plant

The template required for each simulation is shown in Table H1 (Appendix H). This template may be copied to successive vertical locations in the spreadsheet, subject to the limitations imposed by the spreadsheet program and its use of conventional memory. With Disk Operating System [DOS (Microsoft Corp.)] versions of Lotus "1-

2-3", for example, between 15 and 20 simulations may be included in one file. Note, however, that processing speed decreases with each additional simulation due to longer recalculation times for larger spreadsheets. Ranges "form1," "form2," and "form3" were created so templates appropriate for the number of chillers in the plant may be copied quickly.

Required input is generally confined to block locations in the header of the template: one block for the plant, and one block for each chiller. For plants that contain up to three chillers on a common piping loop, the first chiller to be energized is labeled "Lead," and subsequent chillers are labeled "Lag 1" and "Lag 2."

Five inputs are available for plant data. Two inputs for identification data are optional, but inputs for "Design Load," "Winter Load," and "Simulation Model" are required. Design load should be the calculated or predicted load at the appropriate design outside dry-bulb temperature. The spreadsheet will calculate energy consumption beyond this temperature up to the last bin of "% Plant Design Load" included in the body of the template. However, chiller output will be limited to its capacity, subject to the load limit setpoint, for bins where chiller load exceeds chiller capacity. Energy consumption for winter operation in this study is confined to continuous operation at the percent of design load specified for "Winter Load" If the specified winter load falls below the minimum step of chiller capacity specified in equations for columns AC, AZ, and BU, 30 percent for constant speed chillers, and 15 percent for chillers equipped with speed modulation, annual hours of operation at minimum capacity are adjusted to reflect cycling. Simple modifications to data in the column "Annual Occurrence Actual" would accommodate other methods of handling year around operation. The same type of adjustment to annual hours of occurrence is included for summer loads because bins of percent full load may fall below the minimum stage of chiller capacity. Input for "Simulation Model" is presently limited to EQ-1, EQ-2I, EQ-2M, EQ-2S, or EQ-3, which correspond to the five sets of algorithms included for various arrangements of one to three chillers in a single plant. Equation set EQ-1 models a single chiller. Equation set EQ-2I is similar, except it models two chillers with independent chilled water circuits in a single plant. Plant load is prorated to each chiller based on input for "Pro-Rated Load" in the cell that would otherwise be used for "Maximum Lead Setpoint" for the lead chiller. Equation sets EQ-2M and EQ-3 model two or three chillers connected in parallel, whereby chillers share the load in proportion to their capacity, while set EQ-2S handles two chillers in series, whereby the lead chiller modulates while the lag chiller is energized in stages.

Specifications for the lead chiller include 11 input labels or values. Input for "Master Chiller Number (Lead)," "Condenser," "Refrigerant," "Status," and "Configuration"

are optional identification-type data. The remaining six inputs are mandatory. Input for "Compressor" is limited to RECIP, CENT, or SCREW, which determines what column of the look-up table (developed as part of the spreadsheet template) are to be employed for part load efficiency data. If W/ TURBO is entered in the cell immediately to the right, the appropriate column in the same look-up table is consulted for chiller performance with a speed modulation controller. Generic-type values are used in the look-up table unless the user elects to input known values for specific machines as described later in this chapter. The look-up table is located in the upper left corner of the spreadsheet and is shown on page 1 of Table H1 (Appendix H). Input for "Maximum Lead Setpoint" specifies the percent of full load above which the first lag chiller is energized. If equation set EQ-2I is in effect, input at this location specifies the constant percentage of plant load allocated to each chiller. Inputs for "Load Limit," "Rated Capacity," and "Rated Power" are self-explanatory, except that algorithms assume input for the load limit is always greater than input for all other control setpoints. This assumption simplifies all equations for multiple chiller arrangements.

Respective input for lag chillers is the same as described here, with one additional input. If equation set EQ-2S is selected, input for "Minimum Lag Setpoint" determines the percent full load at which the lag chiller operates when it is first energized. As plant load increases, the lead chiller modulates toward full load and the lag chiller remains at its initial capacity. When the load on the lead chiller reaches lead setpoint, an incremental step of capacity is added at the lag chiller. Present algorithms for the series arrangement provide initial, intermediate, and final steps of capacity for the lag chiller in a series arrangement.

Equations that simulate staging for each of the five chiller arrangements are presented near the middle of page 1 of Table H1 (Appendix H). For example, equations EQ-2M-1 and EQ-2M-2 for columns Y and AV determine the load imposed on lead and lag machines for two chillers connected in parallel. As the load imposed on the plant increases from zero, these equations specify that the load imposed on the lead chiller cannot exceed that calculated by the product of rated capacity (tons) and maximum lead setpoint (%). When plant load exceeds this value, the lag chiller is energized, and both chillers share the total load in proportion to their rated capacity. Modulation continues up to the load limit specified for each machine.

Equations EQ-2S-1 and EQ-2S-2 for a series arrangement, are similar. In this case, when the lag chiller is energized, it operates initially at a constant capacity equal to the product of rated capacity (tons) and minimum lag setpoint (percent), while the lead chiller carries the balance of imposed load. When increasing plant loads again cause the lead chiller to reach setpoint, the load imposed on the lag chiller is

increased by 50 percent of available capacity, while the lead chiller continues to modulate. This sequence repeats one final time so the load on the lag chiller can reach 100 percent of its capacity. Interested readers may inspect these equations to determine the logic and sequence of operation for other arrangements, or they may view output in Appendixes I and J to gain a similar understanding.

Input for Different Sites or Load Profiles

The body of the spreadsheet template developed to calculate chiller energy consumption for this report contains columns "% Plant Design Load" and "Annual Occurrence Actual." The former column specifies incremental bins of plant load. It does not require modification unless annual hours of occurrence data do not coincide with these bins, or unless different increments are desired. The latter column specifies the annual profile presented by loads served by the chiller plant.

Utility charges are entered into two cells immediately above the spreadsheet template header. This spreadsheet template can be tailored to the rate structure of the local utility, which in this case is very simple. A one-time peak demand determines the annual demand charge, but consumption is billed at a flat rate. If demand charges were ratcheted to a different time period or, more so, if consumption charges were tiered, the changes probably would require a template for each month of the year, with appropriate changes to cost calculation equations.

Execution of Spreadsheet Macros

Execution of two macros is required to complete one simulation after all required data have been input. These macros are shown in Table H1 (Appendix H). Based on input for "Simulation Model," execution of macro "\A," with the cellpointer highlighting the input cell for plant number, copies the appropriate equation set to columns U, W, Y, AV, and BQ to the body of the template for that simulation. Execution of macro "\B," with the cellpointer highlighting the input cell for master chiller number, determines percent of full load power for each bin of chiller load by interpolating within the appropriate column of the look-up table. Interpolation for successive bins continues until values for all cells in one of columns AE, BB, or BW are determined. This macro must be executed once for each chiller in the plant, although some simple modifications could automate this procedure to include all chillers in one execution.

After copying templates for the desired number of simulations in a particular file, worksheet global protection should be enabled to prevent damage that could be caused by inadvertent execution of a macro with the highlighted cell at the wrong location. With this feature enabled, data can be written only to cells that are "unprotected," and such cells were accommodated during creation of the spreadsheet template.

With all required input at hand, simulation of a single plant with three chillers can be accomplished in 5 to 10 minutes, depending on the type of computer and the number of completed simulations already in the file.

Recommendations for Improving Spreadsheet

Part-load efficiency data in the look-up table for reciprocating compressors represents the average performance of six, York, water-cooled chillers reviewed in Appendix G. Because few air-cooled units were included in this study, their part-load performance is assumed equal to the water-cooled type, i.e., their percent of full load power required at each increment of unloading are equal, not the total power required. Values for centrifugal compressors were obtained from the York catalog for one line of their larger chillers. Although there is some variation among all machines, values taken from this catalog are representative for this type of compressor. The partial load performance of screw compressors, of which there are only two in this study, is assumed equal to that of centrifugal compressors. This results in a conservative estimate of screw chiller energy consumption because their part-load performance exceeds that of a centrifugal chiller.

Two known difficulties exist with the look-up table for part-load performance data. Part-load values taken from all sources represent performance with condenser water reset as described in catalog excerpts included in Appendix G. Part-load efficiencies for centrifugal chillers, for example, are based on a 2½ °F reduction in entering condenser water temperature for each 10 percent reduction in chiller load per Air-Conditioning and Refrigeration Institute (ARI) 550-77[8]. The look-up table, developed as part of the spreadsheet template, is constructed to provide part-load chiller efficiencies based solely on percent full load. However, incorporation of reset, based solely on percent full load, introduces inaccuracies for multiple-chiller plants and for chillers that are not reasonably matched to imposed loads. The error for multiple chiller plants occurs because the look-up table is consulted with a percent-of-chiller-capacity value, but it should be consulted with both this value and a percent-of-plant-capacity value to account for the correct entering condenser water temperature for multiple-chiller arrangements. This statement is true because condenser water reset

and percent-of-plant capacity are both related to outside temperatures; percent-of-chiller capacity in such plants is not. A similar difficulty occurs with grossly oversized chillers. The look-up table inherently assumes, during periods of partial load, that outside air conditions will allow cooling towers to achieve the stated reductions in condenser water temperature. If a chiller is 100 percent oversized, the look-up table will never be consulted with a percent-full-load value greater than 50 percent. Yet there will be periods when the cooling tower cannot produce condenser water temperatures necessary to yield improved efficiencies obtained from the look-up table. The result in both cases is that chiller energy consumption is underestimated.

The inaccuracies described here had minimal impact on the results of this study, so effort was not expended to correct the spreadsheet. The only noticeable impacts occur when a multiple-chiller plant is compared to the same plant operating with only one larger chiller, or when an existing chiller is severely oversized. Because only four instances of such changes were considered in ECO-1, the problem remains to be corrected in future revisions.

The second difficulty with part-load data concerns values in the column for chillers equipped with speed modulation controllers. Percent-of-rated-power values were derived with the pump law that relates capacity and horsepower. Resultant values were then corrected for controller inefficiencies by assuming efficiency deteriorates linearly over the range of the device. These calculations are shown in Table H1 (Appendix H), in the upper center of the page. Although the slope and intercept of the equation that defined deterioration of efficiency are somewhat arbitrary, the addition of a speed control device will penalize overall chiller efficiency as full load is approached. Note that in the look-up table for chillers equipped with turbo-modulators, these chillers require 108 percent of rated power to achieve 100 percent of rated capacity, but 100 percent of rated power produces only 95 percent of full chiller output. This is consistent with actual performance. Comparison of derived values included in the look-up table to other generic sources indicates that values in the table may overestimate the effectiveness of speed controllers on decreasing loads, particularly as chiller loads drop below 50 percent.

Several other improvements could be incorporated into the simulation spreadsheet template to improve accuracy and usability. At present, part-load data for speed controllers represents theoretical values, so actual part-load performance could be obtained from manufacturers and used to more accurately predict performance. Select plants where controllers appear cost effective should be evaluated by the York factory to validate this study or provide information to update this spreadsheet template.

One nonessential improvement to the look-up table would be additional columns to allow modeling of other types of compressors, and perhaps one or two columns for user-defined values. Such changes could be incorporated with minor modifications to the initial instructions in macro "\B".

One change not related to the part-load table may be the inclusion of additional sets of equations to handle unusual chiller arrangements or other sequences of operation. These changes could be included as they are encountered.

A final improvement may be the addition of a minimum load setpoint, below which chiller operation would not be allowed. Present algorithms include a fixed minimum of 30 percent for all chillers except those equipped with a speed modulation controller, where the fixed minimum is reduced to 15 percent. Note that such devices can operate down to 10 percent according to manufacturer's literature. For bins where chiller load falls below these values, the chiller is assumed to cycle on/off at the fixed minimum capacity, so annual hours of occurrence in that bin are adjusted to reflect this condition.

5 Energy Conservation Opportunities

ECO-1: Replace Chillers

ECO-1 is an economic evaluation for replacement of nearly every chiller involved in this study. Only four chillers were excluded from consideration in this ECO: two of these are the relatively new screw chillers in Buildings 31008 and 34008, another is the small air-cooled chiller that serves Building 36009, the fourth is one of the two centrifugal chillers in Building 7051.

Regarding these four buildings, base personnel should be advised that it will be difficult to create an enclosure around the chillers in Buildings 31008 and 34008 and maintain space to service all equipment in these mechanical rooms. Isolation, which eventually must occur for compliance with new refrigerant regulations, appears to require relocation of the chillers into new additions created adjacent to each machine's present location to isolate the chillers. The air-cooled chiller for Building 36009 was excluded because it represents a relatively small load, and there is no space in the mechanical room to install a more efficient machine. Base personnel should be aware, however, that the location of this chiller appears to violate ANSI/ASHRAE 15-1992 recommendations[9] for proximity to building openings. Building 7051 includes two chillers for 100 percent back-up capability. The machine in better condition should be retained for this purpose; the other machine should be replaced as recommended.

Estimates of energy savings and associated construction costs for ECO-1 are provided in Tables I1, I2, and I4 (Appendix I). Estimates of construction costs for upgrading mechanical rooms to meet new refrigerant regulations are shown in Table I5 (Appendix I). Summaries of this information are listed in Tables I6 through I8 (Appendix I). Payback calculations are shown in Tables I9 and I10 (Appendix I), which contain identical information sorted by plant number and payback period, respectively. Tables I8 and I10 (Appendix I) are recommended for a snapshot view and overall understanding of this ECO. Discussions in Chapter 3 outline reasoning that suggests payback periods may be conservative.

The discussion for ECO-1 begins with a section that covers alternate types of equipment considered to improve plant cooling efficiency. Subsequent sections group

the buildings into five categories of chiller replacement options and highlight atypical considerations as appropriate. The last section summarizes results and describes trends between payback periods and plant characteristics.

Analyses of Alternate Chillers and Cooling Towers

Analyses of alternate types of chillers and cooling towers were performed, prior to starting calculations for this ECO, to confirm which types of equipment are most appropriate for various applications at this site. Data accumulated during this effort are included in Appendix G. Several conclusions are worthy of discussion.

Figures G1 and G2 (Appendix G) illustrate installed unit costs and full load efficiencies for five types of chillers that could be recommended to replace existing machines. Tables G2 and G3 and Figure G3 (Appendix G), illustrate the partial load efficiency of water-cooled reciprocating and centrifugal machines. The most striking observation is the soaring unit cost of water-cooled centrifugal chillers as tonnage decreases to manufacturers' minimum offerings of around 100 tons. This fact prompted creation of Table G4 (Appendix G), which is a simple payback comparison of water-cooled centrifugal versus reciprocating chillers ranging in sizes from approximately 125 to 200 tons. The analysis, which included an annual energy simulation for each machine at three different sizes, shows that higher efficiencies of centrifugal chillers, coupled with the significance placed on demand reduction for cost savings, yields simple payback periods from 6.2 years at 125 tons to 3.4 years at 200 tons. The analysis did not account for added maintenance costs associated with centrifugal machines, but it is unlikely such costs would reverse the conclusion that centrifugal chillers should be installed down to sizes at least approaching 125 tons.

A second notable outcome of this investigation results from the same comparison between air- and water-cooled reciprocating chillers. For a fair comparison, unit costs for cooling towers and condenser water circuits must be added to the costs shown in Table G1 (Appendix G) for the water-cooled reciprocating chillers. This adjustment ranges up to $100 per ton for the sizes under consideration, which places a premium of approximately 10 percent on the installation of water-cooled chillers compared to air-cooled. After accounting for the additional electrical loads of cooling tower fans and condenser water pumps, peak demand created by water-cooled plants will remain at least 20 percent less than the demand created by their air-cooled competitors. In the previous comparison of centrifugal versus reciprocating, the premium to install centrifugal units ranged up to 60 percent, yet they were able to overtake the reciprocating units with respectable payback periods because the centrifugal units held a 20 percent advantage in efficiency. The premium to install

water-cooled over air-cooled in this case is much less severe. Therefore, air-cooled equipment larger than 100 tons should not be installed at this site. Note that smaller sizes were not evaluated.

In spite of the lower efficiency of air-cooled chillers, site visits revealed a trend at Fort Hood to replace water-cooled chillers with air-cooled chillers. This recent trend is an attempt to avoid maintenance costs associated with cooling towers and the poor quality of make-up water. However, for a 100 ton load, the annual savings in demand charges alone would exceed $4500 for a water-cooled chiller, which should be ample incentive for proper water treatment. Additionally, installing an air-cooled chiller does not eliminate the need for maintenance.

A final comparison, prompted by maintenance required for condenser bundles in open tower systems, involves the differences between open towers and closed towers with evaporative spray capability. The only potential savings to promote closed towers would occur with decreased maintenance for tube bundles in associated condensers. Closed towers protect tube bundles from deterioration caused by poor water quality. A quick review of installed unit costs and connected electrical loads shown in Table G5 (Appendix G) reveals that closed towers fail both comparisons. Installed unit costs for closed towers range from 3 to 4 times greater than open towers, and connected electrical loads range from 2 to 5 times greater. Therefore, closed towers are not an appropriate substitute for better maintenance, and they were not considered for this study.

Categories of Replacement Upgrades

There are approximately five categories of chiller replacements that allow convenient explanation of this conservation opportunity: replace with similar equipment the same size, replace with similar equipment upsized, replace with similar equipment downsized, replace air-cooled with water-cooled, or replace and combine chillers.

Replace Chillers With Same Size of Equipment

This first category covers one-for-one replacement, using the same size of equipment, and includes 12 chillers in the following eight buildings: 5792, 27004, 36000 (3 chillers), 36006, 36014, 39043 (2 chillers), 41003, and 87018 (2 chillers).

Within this group there are a few special cases. Building 36000, the Main Hospital and largest plant at Fort Hood, contains three York R-11 chillers, two relatively new open-drive machines, and one older hermetic that was down for repairs during all three site visits (same problem each time, filled with air). The two newer chillers

meet preliminary screening requirements for conversion to R-123, as discussed in Chapter 6, "Initial Screening for Potential Candidates," so a potential alternative to replacing all three machines would be to convert two machines and install one new machine with sufficient capacity to account for that lost in the conversion procedure. Economics are discussed in Chapter 9, section titled "Compare Replacement, Retrofit, Conversion, and Maintenance Options."

In building 36006, some increased cost will be incurred to relocate the primary chilled water pump, which would free space necessary to isolate the chiller from other equipment in the mechanical room. A similar situation exists in Building 36014; but, in this building, an inactive absorption chiller and its condenser water pump would have to be removed, and the new chiller and other existing condenser water pump would have to be relocated. The new chiller in Building 41003 also would have to be relocated at some additional cost for piping.

For a quick assessment of all buildings where work beyond basic chiller replacement appears warranted, such as those mentioned here, additional costs are categorized in Table I8 (Appendix I). After the corresponding building number is obtained for a particular additional cost, the appropriate detailed table may be consulted to obtain additional insight regarding the nature of extra expenses.

Replace Chillers With Upsized Equipment

The second category of buildings in ECO-1 appears to require upsized equipment to meet estimated cooling loads. This category includes seven chillers in the five buildings: 410 (2 chillers), 14020, 14023, 21002, and 28000 (2 chillers).

A special requirement common to the three single-chiller buildings appears to be the need for a larger cooling tower. Towers in the 14000 series buildings need to be replaced because of their present deteriorated condition. The other two buildings are identical division headquarters facilities that have the only two, site-erected, masonry cooling towers on the post. These highly visible and aesthetically pleasing structures were determined to have sufficient capacity to handle a 10 percent increase in load; no data on their construction was available to calculate their performance limit. The only other additional cost for this group of buildings is expansion of the mechanical room in Building 21002 and relocation of the new chiller to isolate it from other existing mechanical equipment.

To compare new and existing conditions for this group of buildings, additional energy consumption simulations were performed that limit capacities of new equipment to match capacities of existing equipment. Table I3 (Appendix I), shows simulations for

new conditions that include demand setpoints. Results from these revised simulations were used in payback calculations to allow a fair assessment of payback periods for plants in this group.

Note that this is the first category of buildings in which replacement cooling towers are discussed. New towers are included in this ECO only where upsized chillers are recommended, except as noted, or where air-cooled chillers are replaced with water-cooled equipment. For all other existing towers, an allowance (of approximately one-third the cost of a new tower) is included to replace the fill and otherwise refurbish such cooling towers. Most towers need at least some portion of this allowance. In Table I8 (Appendix I), this allowance is flagged by the suffix "A" in the column for additional costs associated with cooling towers.

Two of the buildings requiring upsized chillers, 410 and 28000, contain two chillers each. It may be possible to replace the chiller in the worst condition with a larger, high-efficiency chiller that is able to meet the increased cooling load. This new chiller would be used as the lead chiller by baseloading it. Peak cooling loads would be met by operating the existing chiller in addition to the new chiller.

Replace Chillers With Downsized Equipment

The third category of buildings, which covers one-for-one replacement with downsized equipment, includes 11 chillers in the following eight buildings: 121, 194, 2805, 7050 (2 chillers), 7051, 29005 (2 chillers), 39015 (2 chillers), and 42000.

For extra costs, Buildings 121 and 2805 appear to require additions to isolate the new chillers and to allow service access for all equipment. Chillers in Building 39015 will have to be shifted several feet to satisfy these same requirements. Piping deficiencies in Building 42000 (e.g., misaligned piping) should be corrected during installation of the new chiller.

Replace Air-Cooled Chillers With Water-Cooled Equipment

The fourth category of upgrades replaces air-cooled chillers with water-cooled equipment. It includes one chiller each for Buildings 50001 and 91001. A third such building is discussed in the next category.

Building 50001, a commissary, presents a challenge regarding placement of the new cooling tower. The two existing condensers are located within a screened utility area (solid concrete wall with bottom openings) that also houses numerous condensing units for coolers and freezers. The condensing units are equipped with discharge

ductwork that, unfortunately, directs hot exhaust air toward the intakes of the condensers. An alternate location is required for any type of chiller heat rejection equipment because there is no suitable space within the screened area.

The new cooling tower for Building 91001 can be installed where the air-cooled chiller is presently located, which happens to be the site of the original cooling tower that served this building. The new chiller can be installed in the same basement location as the original machine, but an isolation enclosure must be created around the new chiller to meet current codes.

Replace and Combine Chillers

The seven chillers in Buildings 135 (two chillers), 5764 (two chillers), and 50004 (three chillers) present three different opportunities to improve efficiency and reduce maintenance by decreasing the number of chillers to one per building.

The upgrade for Building 135 replaces two small reciprocating chillers with a similar, downsized, water-cooled machine. This presents an opportunity to eliminate at least one other air-cooled unit on the opposite end of the building that was not included in this study. The new cooling tower undoubtedly would have to be relocated. Piping modifications would be required to combine the existing independent, chilled-water circuits, and should be considered. This probably could be accomplished with a new primary loop and pump to salvage the existing chilled water pumps and allow the flexibility they provide. The building contains small retail shops that could require different operating schedules.

Building 5764, the Officer's Club, is served by one water-cooled chiller in the basement and a supplemental air-cooled unit, adjacent to but screened from the cooling tower. The second chiller was discovered after all field trips were completed. Drawings indicate that the chillers are connected in parallel, and only one chilled-water pump was found in the mechanical room. Therefore, extra costs for replacement with a single, downsized chiller are limited to a new cooling tower and some extra demolition of mechanical equipment. Both the chilled and condenser-water pumps are assumed to be suitable for reuse with the new chiller.

Building 50004 will require substantially more cost for chiller replacement than most other buildings, but it ranks fifth best in terms of net simple payback and ninth best for gross payback. In this building, three 125-ton, water-cooled, centrifugal chillers are used to met a 306-ton cooling load and should be replaced with one chiller. The three cooling towers are in relatively good shape and can be reused by manifolding their pipe runs just inside the building. The primary reason for increased costs is

work necessitated by refrigerant codes to isolate the chiller. Large air-handling units and overhead ductwork are problems in this mechanical room. The floor area is rather generous but occurs at unusable locations. It appears that the best location for the new chiller would be the same corner of the room where the newest of the three existing chillers is installed. However, the two older chillers, related pumps, and the majority of large piping are all at the opposite end of a long, narrow room. Costs assume that all pumps and a fair portion of the piping will be replaced. A primary/secondary loop that reuses existing chilled-water pumps should be considered.

Results and Trends

Inspection of net payback periods calculated in Table I10 (Appendix I) reveals that two-thirds of the plants have the potential for success in a life-cycle cost analysis. Seven of 26 plants show net simple payback periods of less than 10 years; 10 additional plants follow with payback periods of less than 18 years. If maintenance procedures were improved so new equipment would realize its entire lifespan, upgrades to all of these plants would be justified.

Four of the five largest plants are among the seven with the best payback periods, and capacity reduction seemed only a minor factor for the two of these four in which a reduction is recommended. The fact that all of these plants have mid 1970s Trane chillers is not significant; Trane equipment seemed to be the predominant choice at that time. There was no other correlation between plant capacity and payback period, and correlation between reduction in plant capacity and payback was not strong.

Seven of the remaining nine plants have net payback periods ranging from 21 to 72 years, and upgrades at two plants show negative payback periods. This group of plants with extended payback periods included all four water-cooled, reciprocating chillers recommended in the ECO. Efficiency improvements for this type of compressor were no greater than 8 percent. However, efficiencies used for some existing chillers were only estimates due to the lack of any other data. Building 194 showed negative payback because the method for modeling part-load chiller efficiency with condenser water reset does not account for oversized equipment, and the existing chiller is estimated to be 113 percent oversized (this modeling shortcoming is explained in Chapter 4). When this plant was modeled without reset, energy cost savings changed to $2609 per year, which yielded a simple payback of 27 years. Building 36006, the other plant with negative payback, contains a relatively new R-11 chiller with a nameplate efficiency of 0.67 kW/ton. When replaced with a new

R-123 chiller, whose efficiency of 0.68 kW/ton is slightly less due to the type of refrigerant, the result is negative payback.

ECO-2: Install Variable Speed Drives for Chillers

ECO-2 considered variable speed drives for a select group of chillers. Initial qualifying requirements assumed plant capacities in excess of 200 tons, or year around plant operation. Several potential candidates were disqualified because their size fell below this assumed capacity threshold. For reference, Turbo-Modulator Drives can be applied to motors from 150 to 500 hp.

Individual plant simulations are included as Table J1 (Appendix J). A summary of energy costs is included as Table J2, and payback calculations are listed in Table J3 (Appendix J). Eleven of 13 plants show promise of benefiting from installing variable speed chiller drives. Their simple payback periods are all less than 13 years, with five plants showing less than 10 years. The two other candidates that appear to drop out of contention are the plants with existing screw chillers, and this strictly is due to increased capital costs for retrofit installations. When chillers and drives are ordered and installed as a packaged assembly, which was true for the other 11 machines, the cost of including a drive is less than retrofitting a drive to an existing machine. Additionally, these chillers are relatively new and in reasonably good condition. Because screw chillers have good part-load performance characteristics, these chillers should not be considered for variable speed drives.

For reasons detailed in Chapter 4, the performance of chillers equipped with variable speed chiller drives was predicted with derived values for part-load performance. Factory modeling for all subject plants is highly recommended to confirm performance predicted herein. Factory simulations should indicate performance both with and without the drives to minimize differences between modeling techniques and actual cooling loads.

One limitation of variable speed chiller drives must be noted when considering their performance. As chiller speed modulates toward 100 percent, inefficiencies inherent with such drives become noticeable because percent-of-full-load power begins to exceed 100 percent. The crossover point is typically about 95 percent of rated chiller capacity. Thus, to avoid the penalty of increasing demand above the value that would occur without the drive, chillers were modeled with a load limit of 95 percent. If new chillers are selected with rated capacities slightly larger than design loads, the effect of this limitation would be avoided but at the expense of purchasing a

larger than required chiller; this would add to the initial cost and increase the payback period.

ECO-3: Install Variable Speed Drives for Pumps

ECO-3 attempted to apply the same strategy of speed modulation to existing chilled water pumps, which would become variable speed secondary pumps after plant pumping arrangements were revised. However, this ECO is not feasible due to the increased capital costs for creating primary pumping circuits within the plants and for installing two-way valves and associated controls at each remote building (or cooling coil for smaller plants) to throttle secondary flow. In addition, this ECO will not reduce demand charges, which account for an estimated 60 percent of pump operating costs.

Informal calculations for Building 39015, the second largest plant on the base, are included as Appendix K. An estimated savings of $7,000 per year was predicted using several assumptions that err in favor of inflated savings. Calculation of pump energy consumption for the new condition assumed that both the primary and secondary pumps were equipped with variable speed drives. However, the new primary pumps cannot realize this savings because they must operate at full load at all times. In addition, energy consumption for the new condition was calculated with pump laws; this calculation does not account for inherent inefficiencies in variable speed drives. Realistic savings with more sophisticated calculations could reduce savings to $5,000 or less per year. Capital costs within the plant were quickly estimated to exceed $57,000. Capital costs at 18 secondary/tertiary loop connections would be at least $2,000 each, depending on the size and quality of the two-way valves. Material costs alone for pressure-independent valves and associated controls (best quality and performance) would be $2,000 per building. With appropriate contingencies, simple payback periods range upward from 15 years. Therefore, no further consideration was given to this ECO.

ECO-4: Replace Fan and Pump Motors

This conservation measure involves replacement of standard efficiency motors with high- or premium-efficiency motors. It can be implemented in one of two ways: with a wholesale motor change-out as considered herein or with individual motor replacements that naturally occur over the life of such equipment. Payback periods shown in Table K1 (Appendix K) for individual pump motors indicate that wholesale replacement appears warranted, although it is marginal for some motors. Calcu-

lations were not performed for cooling tower fan motors; but, because these motors do not operate continuously and labor costs will be slightly higher to replace fan motors in most towers, wholesale motor replacement is not recommended for cooling towers. However, high efficiency motors should be used when normal replacement of motors is required.

Energy consumption for pump motors is based on the operating point plotted from flow data contained in the EEAP report[2]. A large number of pumps could not be evaluated for numerous reasons, but the remaining pumps provide a representative sample from which conclusions can be drawn. Efficiencies for existing motors were obtained from nameplates or data provided by motor manufacturers. Efficiencies for new motors were obtained from a database of high-efficiency motors available from the Washington State Energy Office*. Payback periods include the effect of the local utility rebate. Every replacement motor selected from the database qualified as a premium-efficiency motor, which increased rebates by $2.00 per horsepower.

Two items should be included to end this discussion. Figures E1 and E2 (Appendix E) document the large number of pumping circuits that are flowing at less than 90 percent of design values. When flow in these circuits is corrected, energy savings from high-efficiency motors will serve to buffer only an overall increase in energy consumption. Also, current policies or procedures for obtaining replacement motors suggest disregard for the incremental cost of obtaining high-efficiency motors. Utility literature[4] cites payback periods from 1 to 2 years for conditions in which the motor would be replaced for any other reason. Few replacement motors observed during site visits were the high- or premium-efficiency type.

ECO-5: Implement Demand Limiting

The economics of this opportunity were not quantified because implementation depends on subjective judgments about what setpoints and resultant indoor conditions will be tolerated by building occupants. Human nature guarantees that initial reactions to implementation will be unfavorable. The first observable symptom will be friction between the building occupants and maintenance personnel, whose probable (and understandable) response will be to disable any controls that are creating the problem. The prime motivation for good maintenance procedures is that complaints are reduced or eliminated if ample cooling is provided. If

* An inventory of motors, their efficiencies, and prices was first published in 1991, and updated annually thereafter; Motormaster Database, developed by the Washington State Energy Office, Olympia, WA; phone, 360-956-2000.

implementation of demand limiting was suspected of creating complaints due to lack of cooling, it is likely that limiting setpoints or devices would be removed.

If demand limiting causes no occupant complaints, implementation costs of demand limiting will be minor compared to potential savings because the spine of a basewide energy monitoring and control system (EMCS) is currently being installed. All new chillers should be purchased with the capabilities to interface with the EMCS. Options for remote input should cost less than $1000 per chiller and are becoming standard equipment with some manufacturers. The remainder of the installation should include no more than 100 ft of communications cable per chiller to link them to interface panels of the basewide utility control system (UCS).

Savings in demand charges can be calculated readily for any demand setpoint. For example, each 1 percent reduction in demand for a 1000-ton plant operating at 0.6 kW/ton results in a savings of $916 per year. The simple payback period for such a reduction would be less than 2 years. Thus, realistic setpoints, such as a 95 percent demand limit, would have payback periods measured in months.

ECOs Beyond Central Plant Boundaries

Several conservation opportunities with virtually no capital cost exist in remote buildings. The most obvious are rows of open windows in barracks buildings where some occupants complain of being too cold, while ambient temperatures are above 90 °F. The air-side systems are in dire need of repair and balancing. The payback period for making these corrections would be several months.

While spot-checking remote buildings to confirm types of primary/secondary loop connections, a number of air handlers in barracks buildings were observed to be operating on 100 percent outside air. The primary culprit was loose or missing set screws in damper linkage hardware. These conditions could have been created by poor maintenance, or by the resident's desires for improved ventilation. Again, payback periods would be several months.

6 Chiller Conversion and Retrofit Options

Primary Options

Four primary options are available to change from CFC-based chillers to CFC-free operation: refrigerant conversion, driveline retrofit, and replacement of the entire machine, either immediately or at the end of the chillers useful life. The replacement options, which are addressed as ECO-1 in this report, are self-explanatory and require no discussion in this chapter, except for interim measures that should be implemented for delayed replacements. Therefore, the focus of this chapter is the need and procedure for considering the conversion and retrofit options.

As explained in Appendix A, the need to change to CFC-free chiller operation is actually an implicit requirement that results from regulations which ban production of CFC refrigerants after 1995. Continued operation of CFC-based chillers is acceptable subject to limitations on the quantity of refrigerant that legally can be discharged to the atmosphere (15 percent of system charge annually). Therefore, owners can operate CFC chillers until their private refrigerant inventories are depleted, until such refrigerants are no longer available from market sources (i.e., companies that recycle used CFC refrigerants), or until the latter option becomes cost-prohibitive. When all refrigerant sources are expended, owners must change to CFC-free chiller operation or they will be unable to provide refrigeration-type cooling.

Owners who are contemplating chiller replacement in the short-term future should be aware of the potential for a severe shortage of such equipment. Maximum production capacity of the major chiller manufacturers, for machines 200 tons and larger, is estimated to be 6500 chillers per year. Of this amount, 4000 units per year are expected to fulfill the requirements for new construction; the remaining 2500 units per year appear to be available to replace existing equipment. Recent CFC regulations will affect an estimated 80,000 existing machines. Obviously, there will be a shortage of new machines for owners who select the immediate replacement option. Therefore, owners must be prepared to consider nonreplacement options: refrigerant conversion or driveline retrofit.

The likely shortage of new chillers is only one of several reasons why owners should consider conversion and retrofit options. Owners of relatively new machines may discover that a simple conversion is appropriate for their equipment at a fraction of the cost of a new chiller. This would be true especially if gaskets in these newer chillers happened to be, and quite possibly are, compatible with non-CFC refrigerants. Other owners may learn that a driveline retrofit will increase operating efficiency, again at less cost than a new machine. The likelihood of this benefit increases if a downsized replacement compressor can be coupled with existing tube bundles that have surface areas in excess of those required to meet the cooling load.

Detailed investigation and analysis of all information required for conversion or retrofit options are beyond the scope of this energy study. Preliminary recommendations contained herein for conversion or retrofit are based on a preliminary screening to determine the most likely candidates for these options. The next step in the evaluation of candidates involves on-site investigation and testing of specific components by trained service personnel and design calculations and selection of replacement components by factory engineers to certify the performance of upgraded equipment. At these stages of the process, each machine must be studied individually—generalizations are no longer appropriate. As such, these steps represent an investment of time for which compensation may be warranted. Manufacturers typically charge a nominal fee for engineering work associated with certifying upgraded performance. If the owner elects to pursue that upgrade, this charge is often credited against the cost of new components. This report does not certify the potential for nonreplacement options, nor does it include an exhaustive list of such options. Instead, this report favors a simplified approach to cover the range of possible alternatives and, as such, should be considered as the initial draft of a plan to cope with CFC issues.

Conversion and retrofit opportunities identified during this study are based, in part, on information provided by Natkin Service Company (Seattle, WA branch). This firm is an independent, nationwide, contracting firm with considerable experience servicing all major brands of chillers. Information also was provided by York International Corporation, which is the unquestioned leader among major manufacturers in this relatively new aspect of the chiller industry.

Other manufacturers still are developing their approach toward converting and retrofitting existing chillers. Their experience is limited and typically applies only to their own equipment. Representatives at the Trane factory declined to participate in the conversion/retrofit aspect of this project, stating that their engineering staff was overloaded with projects of this nature. Local Trane sales representatives will

be charged with handling initial calls concerning refrigerant-related upgrades as soon as they can be properly educated.

York, however, offers conversion and retrofit packages for chillers of nearly every type and manufacturer, and it has a record of successful installations that predates the CFC-free chiller issue.

Carrier's policy is to avoid all but new installations of their equipment. However, they are advertising a "Chiller Operation Assurance Program" which promises owners that their existing R-11 chiller will operate until the year 2000 or Carrier will replace the machine free of charge. To qualify, owners must equip their machines with Carrier refrigerant conservation devices and enter into a Carrier service agreement.

Initial Screening for Potential Candidates

Initial screening of existing chillers, to determine the need and type of CFC-free chiller upgrade, followed a logical analysis of plant requirements and chiller nameplate and performance data. Steps included the following:

- Note type of refrigerant. Consider upgrades for all CFC-based chillers.
- Compare actual or estimated peak cooling load to rated capacity of existing equipment. Note whether upsizing is required or downsizing may be appropriate.
- Note manufacturer, model number, production date, type of compressor and drive, and pressure rating of shells. Determine whether refrigerant conversion appears feasible, if driveline retrofit appears available, or if chiller replacement is the only possible solution.
- Conversions and retrofits are not considered for reciprocating compressors and should not be considered for extremely old equipment (30 years or older).
- For relatively new chillers (10 years or younger) or for York chillers in general, if conversion appears feasible, retrofit may not be necessary unless the peak cooling load exceeds post-conversion capacity. At that point, other ECOs to reduce cooling loads may be more cost effective, i.e., lighting retrofits save energy directly and reduce cooling loads.
- For potential conversion and retrofit candidates, eliminate candidates whose post-upgrade cooling capacity will be less than the estimated cooling load, consider other energy conserving methods to reduce cooling loads, or relocate machines if they can be used successfully elsewhere.

- For remaining conversion candidates whose manufacturer is out of business or has become part of another company (Westinghouse for example), consider the future availability of spare parts.
- For remaining retrofit candidates with multistage compressors (typically Trane), consider the difficulties in obtaining a suitable replacement compressor. Design philosophies for optimizing compressors or tube bundles differ among manufacturers. Trane tends to concentrate on sophisticated compressors, and York appears to focus on optimizing tube bundles. Thus, compressors are not always interchangeable between manufacturers.

Tables M1 and M2 (Appendix M) present results of the initial screening of major chillers at Fort Hood. The tables contain identical information but list data according to different sorting criteria for ease of use and understanding. Information in the left-hand portion of Tables M1 and M2 (Appendix M) represents some of the most relevant data that must be reviewed in the initial screening. The right-hand portion of Table M1 (Appendix M) represents assessments based on the best available information. The right-hand section of Table M2 (Appendix M) shows similar types of assessments furnished by York International Corporation and Natkin Service Company, a manufacturer and contractor, respectively.

The costs shown in Tables M1 and M2 (Appendix M) for eddy current testing represent an average cost per chiller, without regard to chiller size or other characteristics. The grand total cost for testing is a realistic value based on a scenario developed by Natkin Service Company with actual tube characteristics for each machine. Qualifications furnished with Natkin's grand total estimate specified that one head shall be removed from each machine, and that all tubes shall be cleaned prior to the start of testing work. Worst case scenarios were assumed, so some cost savings could be realized if all chillers in any plant could be tested at the same time.

Costs for new rupture disks and high-efficiency purge units would apply only to machines scheduled for delayed replacement. These devices are intended to minimize the loss of refrigerant in the event of an over-pressure emergency discharge, or during normal purge cycles for low-pressure machines. Current styles of high-quality rupture disks are designed to reset when system pressure falls to 90 percent of the maximum allowable pressure within the chiller. Older style disks (standard carbon bursting design) are not reusable and allow complete discharge of all refrigerant in the machine. High-efficiency purge units employ improved condensing techniques to reduce the ratio of refrigerant-to-air released to the atmosphere during normal discharge cycles.

Costs to upgrade each machine correspond to the type of upgrade listed in the right-hand columns of Tables M1 and M2 (Appendix M). Ratios of upgrade cost to replacement cost compare the upgrade cost listed in this table to the cost of a chiller subassembly listed in Table I8 (Appendix I). Note that ratios for simple conversions, for which six candidates are identified, range from 15 to 20 percent of the replacement cost. Retrofit costs for the remaining low-pressure candidates range from 50 to 80 percent of the installed cost for a new machine, with a number of candidates at less than 60 percent. None of the R-12 chillers appear on the candidate list, primarily because most are Westinghouse units and York, the only potential supplier, cannot provide a retrofit compressor for these machines.

Additional Steps To Confirm Feasible Upgrades

Initial screening is the practical extent to which owners of chillers can realistically participate in the upgrade process. Beyond this point, their participation is necessary to fund testing procedures and is strongly recommended so they can make informed decisions. Personnel responsible for operation of chiller plants at Fort Hood should begin contacting engineering consultants, chiller manufacturers, and qualified refrigeration contractors to proceed with the following work:

- Evaluate physical condition of components, in terms of performance and compatibility with alternate refrigerants, and perform applicable tests. An eddy current test to determine the condition of evaporator and condenser tubes is mandatory. Leak detection, vibration analysis, and full-load tests should be performed for conversion candidates, as should a complete checkout of all other mechanical and electrical components.
- Identify components that must be replaced.
- Certify expected performance after upgrade, including cooling capacity (tons) and operating efficiency (kW/ton), and compare to performance of a new machine.
- Estimate cost of upgrade and compare to cost of a new machine. Confirm that life-cycle cost of upgrade is acceptable.
- Initiate upgrade or purchase a new machine. Include related work necessary to upgrade mechanical room to current code requirements and, when appropriate, piping modifications to improve “system” performance.

7 Maintenance Procedures

Existing Conditions

Maintenance procedures received a dismal appraisal in the EEAP report[2], based on site visits performed in the late 1980s for that study. If sincere effort had been put forth since then to correct the kinds of deficiencies the report[2] documented, noticeable improvements should be evident by now. Judging from physical appearances alone, maintenance procedures have not improved. In fact, they may have deteriorated enough that the opportunity to perform maintenance does not exist. Emergency response would seem to characterize the present situation accurately in many of the chiller plants visited during the course of this study.

Examples of the variety of equipment difficulties witnessed during site visits should be documented. Beginning with the chillers, seven machines were operating with load limits set below full capacity, the lowest setpoint of 60 percent was found on the lead chiller in Building 39015. These limits are set because the machines are not capable of performing at peak output. Control panels for the chiller in Building 36006 and for one of the three machines in Building 36000 indicate excess purge cycles, which is a basewide difficulty. As mentioned previously, another R-11 chiller in Building 36000 had been out of service for months because it was filled with air. The chiller in the basement of Building 5764 was low on charge. There were empty cans that would hold 1700 lb of refrigerant stacked next to this chiller, and its charge is 500 lb. When the chiller in Building 121 was tested to full load, its low temperature cut-out tripped, which indicated low charge or water flow. Some machines that showed signs of recent repair were reassembled and sealed with what looked to be "home-made" gaskets. It is doubtful that all of these chillers could have developed problems of the severity noted here since the end of the winter maintenance season.

Although chiller log books are not an item of equipment, they deserve special mention due to their importance in diagnosing the performance of chillers. The log books at Fort Hood contain entries for date, time, name, oil temperature or pressure, and an occasional description of a maintenance event. Entries limited to this extent are essentially useless. A properly completed chiller log sheet should contain at least two dozen items of information such as entering and leaving water temperatures and pressures; suction and discharge temperatures and pressures; condensing pressure,

corresponding temperature, and actual temperature; oil pressure and temperature, amp draw, setpoint, etc. In addition, the log book should contain these same values at full load conditions, as stated by the manufacturer, to provide a reference point for comparison with actual values.

An example illustrates the value of recording these values and understanding what they mean. Assume measurements taken on a typical R-11 chiller include a condensing pressure of 13 psig measured in the shell and a condensing temperature of 105 °F measured in the liquid line leaving the condenser. From standard refrigerant tables, the saturated temperature corresponding to 13 psig is approximately 110 °F. The 5 °F temperature difference between the corresponding and actual condensing temperatures indicates a problem (1 to 2 °F normally is acceptable). In this instance, the condenser probably contains air or noncondensables that create a loss in efficiency because compressor discharge pressure is higher than required.

Cooling towers, which offer little challenge in terms of maintenance, show signs of widespread neglect. Of the 19 towers known to have bypass-valve control, the valves for at least 11 towers were "frozen" in position, disabled, disconnected, or otherwise inoperable (some had disconnected actuators dangling in place). Excessive vibration was observed in three towers. Make-up water for one system appears to be fed manually through a hose connected to the blow-down valve of the pump strainer. Most noticeable, however, are mineral deposits on fill material. Some of these deposits are at least one-quarter inch thick. The majority of towers require attention for this problem and, to a lesser extent, for excessive biological growth.

The most revealing observation, however, is the overall physical appearance of the equipment and mechanical spaces, leaking pumps, valves, and fittings and old equipment (pumps and controls) left laying in the corner of mechanical rooms when repairs were completed. This evidence is significant because it reflects the prevailing attitude. If allowed to continue unchecked, this attitude may destroy attempts at energy conservation.

Refrigerant Consumption

Table 3 is a copy of the best available record of 1993 refrigerant consumption at Fort Hood. USACERL is attempting to track the flow of this material through various maintenance shops so, at this point, the amount of each refrigerant consumed by chillers in this study is unknown.

Table 3. Fort Hood refrigerant usage for the 12 months ending May 10, 1993.

Refrigerant	Vol./Wt	# Cans	Total used	$/Can	$/lb	$ Total
R-11	55 gal	79	4,345 gal (~53,850 lb)	696.00	1.02	54,984
R-12	30 lb	1970	59,100 lb	223.00	7.43	439,310
	50 lb	742	12,100 lb	370.00		89,540
R-22	30 lb	698	20,940 lb	46.35	1.54	32,352
	50 lb	148	7,400 lb	75.60		11,189
R-113	100 lb	13	1,300 lb	736.00	7.36	9,568

Two of the refrigerants listed in the record, R-11 and R-113, have limited application beyond central plant chillers. Although analysis of their consumption is necessarily speculative at present, such an analysis would illustrate an important point. The total charge of all R-11 machines in this study is approximately 16,500 lb. At the legal discharge rate (for space conditioning operation) of 15 percent of system charge annually, 2475 lb per year of this material could be discharged to the atmosphere before the U.S. Environmental Protection Agency (USEPA) could begin investigation of the problem. The inventory shows that 53,850 lb of R-11 was consumed during the 12-month period of record. If all R-11 consumed during this period could be traced to these chillers, the resulting consumption rate would exceed the legal limit by a factor of 22. Similar calculations for R-113 yield a factor of 4. If a substantial number of additional users is not identified, the magnitude of these consumption rates is a serious problem, both legally and economically because availability of these refrigerants is declining and cost is increasing.

At the time this study was undertaken, the cost of this problem could not be included in payback calculations for reasons discussed here. However, if the analyses in the preceding paragraph were applied to costs, the savings would amount to $2900 per year for each R-11 chiller and $1900 per year per chiller for R-113. The unit cost for the R-12 chiller probably would be similar. However, there are a host of other probable users, including refrigerators and freezers for food, so the total cost for consumption of R-12 cannot be attributed to chillers alone. Additional discussion of the refrigerant use is given in Chapter 8.

Alternative Approaches

Natkin Service Company estimates (personal communication) that a crew of two journeymen, two helpers, and one lead refrigeration mechanic could adequately service the chillers and related equipment included in this study. The number of

civilian employees that presently maintain these chiller plants is unknown, but it is not less than five. Therefore, a problem exists and alternate solutions are available.

Private service contracts are one potential approach to restore respectability to operation and maintenance of central plant equipment. Implementation could be tailored to several objectives. If unqualified personnel are contributing to the problem, the contract could be arranged to supplement the current staff and provide on-the-job training. Training should begin with preventative maintenance procedures and move toward predictive procedures. Vibration analysis, for example, is used successfully elsewhere to predict and avoid more costly repairs that ultimately will be required.

Lack of incentive and motivation are evident problems that may be reversible through competition. Contracts for total maintenance of a select group of plants could be arranged so their annual performance can be judged against comparable plants maintained by present staff. This arrangement would be unusual but probably enlightening.

Third-party ownership and operation with shared savings is another possibility. This arrangement could be incorporated into the plant upgrade projects, whereby contractors would bid to provide cooling capacity for some time period, and they would remain responsible for operation of the plant after construction. This concept may be applied successfully to the large stand-alone plants.

As mentioned previously, life-cycle cost savings will never be realized if the quality of maintenance remains at present levels.

8 Chiller Inventory and Refrigerant Use

In March 1993, USACERL personnel surveyed all readily located, air-cooled chillers at Fort Hood. This survey covered 514 air-conditioning units. Its intent was to identify and categorize air-conditioning equipment not covered in the MEIP study of central plant chillers. USACERL personnel gathered available nameplate data and supplemented this with manufacturer's data. USACERL personnel surveyed a representative sample of each building type (e.g., barracks, administration, and recreational facilities). Due to the short time and unavailability of equipment to test the units for actual refrigerant charge, USACERL considered nameplate refrigerant charge values to be correct. This survey was then combined with an earlier EEAP study[2] to cover a total of 554 units.

The units ranged in size from 2 to 645 ton capacity. Of the 554 units, 27 units were under 5 ton capacity, 366 units were between 5 and 25 ton capacity, 100 units were between 26 and 100 ton capacity, 25 units were between 101 and 200 ton capacity, 16 units were between 201 and 500 ton capacity, 7 units were over 500 ton, and 13 units had an undetermined capacity. The total cooling capacity of the units surveyed was 15,616 tons. The surveyed units in each capacity range break down into the following percentages: 5 percent of all units were under 5 ton, 66 percent were between 5 and 25 ton, 18 percent were between 26 and 100 ton, 5 percent were between 101 and 200 ton, 3 percent were between 201 and 500 ton, and 1 percent were over 500 ton capacity (Figure 1)*.

These percentages do not show the total impact of the number of units on total cooling capacity provided by each group. The 27 units under 5 ton, 5 percent of the total number of units, provided only 0.36 percent of the total post cooling capacity. The 366 units between 5 and 25 ton, 66 percent of the total, provided 18 percent of the total cooling capacity. The 100 units between 26 and 100 tons, 18 percent of the total number of units, provided 23 percent of the total post cooling capacity. The 25 units between 101 and 200 ton, 5 percent of the total number of units, provided 15 percent of the total post cooling capacity. The 16 units between 201 and 500 ton, 3 percent of the total number of units, provided 26 percent of post cooling capacity. The 7 units over 500 ton, 1 percent of the total number of units, provided 17 percent

* Figures are at the end of the chapter.

of the cooling capacity. Even though the units over 100 tons only accounted for 9 percent of the total number of units, they provided over half (58 percent) of the total cooling capacity surveyed. The breakdown of total post cooling capacity provided by air-conditioning units in each size range is shown in Figure 2.

An important issue to consider is the amount and type of refrigerant used in each of the four different capacity ranges. The total amount of refrigerant used in all the units surveyed was 53,919 lb. Of this amount, 21,981 lb (41 percent) was R-11, 21,708 lb (40 percent) was R-22, 7,207 lb (13 percent) was R-12; and 3,203 lb (6 percent) was R-113 (Figure 3).

The graph in Figure 4 shows the percent of each type of refrigerant usage as broken down by capacity range. R-22 is almost exclusively limited to use in units under 100-ton capacity. R-11 is used primarily in units above the 100-ton capacity range.

Of the units surveyed, 92 percent used R-22, but this 92 percent accounted for only 45 percent of the total cooling capacity surveyed. This is due to the fact that 73 percent of the units using R-22 were in the 5- to 25-ton capacity range.

Four percent of the units surveyed used R-11, but this 4 percent represented 37 percent of the total cooling capacity surveyed. Note that all units using R-11 were over 100-ton capacity. Of the units in the 101- to 200-ton capacity range, 28 percent used R-11, 56 percent of the units in the 201- to 500-ton capacity range used R-11, and 100 percent of the units over 500 ton used R-11 (Figures 5 and 6).

Figure 6 shows that, if the chillers using R-11 were replaced with chillers using environmentally friendly refrigerants, only 4 percent (22 chillers) of the chillers surveyed would have to be replaced to remove 41 percent of the refrigerant usage on base. In contrast, 92 percent (498 chillers) of the chillers using R-22 would have to be replaced to remove 40 percent of an unfriendly refrigerant (Figure 7).

Only 2.8 percent of the units used R-12, and these accounted for 12 percent of the total cooling capacity. Less than 1 percent of the units under 5-ton capacity used R-12. No units in the 26- to 100-ton range used R-12, 24 percent of the units in the 101- to 200-ton capacity range used R-12, 38 percent of the units in the 201- to 500-ton capacity range used R-12, and none of the units over 500-ton capacity used R-12. Also, R-12 is an obsolete refrigerant which is being phased out of production by the end of 1995. To replace R-12, which accounts for 12 percent of the cooling capacity surveyed, 3 percent of the units surveyed would have to be replaced. This 12 percent becomes a more relevant concern after comparing the price per pound of R-12 vs. R-11 paid by Fort Hood (Table 3).

Only 1.1 percent of the units used R-113 as a refrigerant, which accounted for 5 percent of the total cooling capacity. The only units that used R-113 were in the 101- to 200-ton and 201- to 500-ton range; 20 percent of the units in the 101- to 200-ton capacity range used R-113, and 6 percent of the units in the 201- to 500-ton capacity range used R-113.

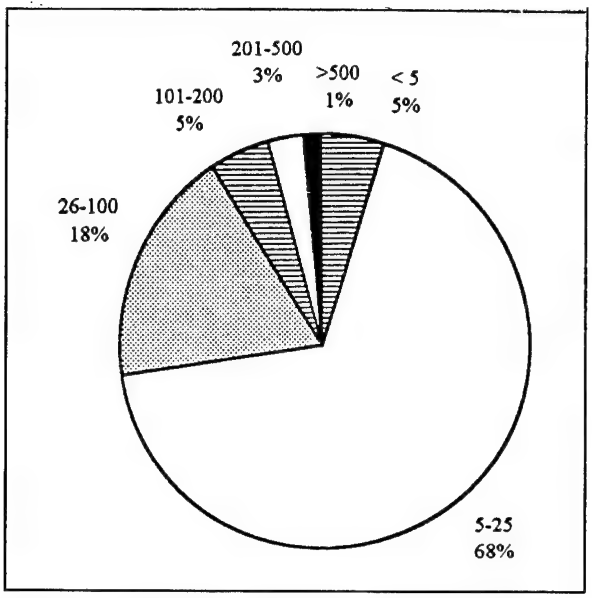

Figure 1. Percentage of units in each capacity range.

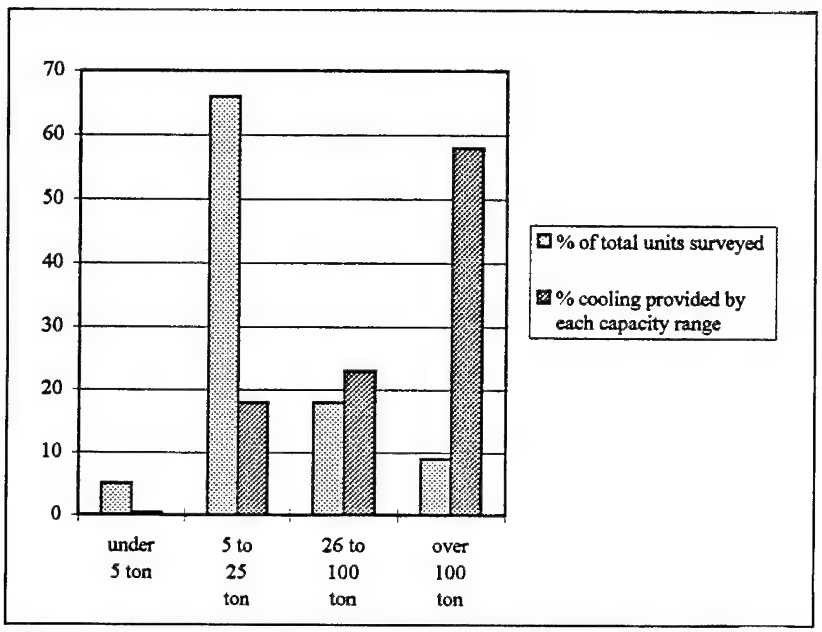

Figure 2. Percentage of units surveyed versus percentage cooling capacity.

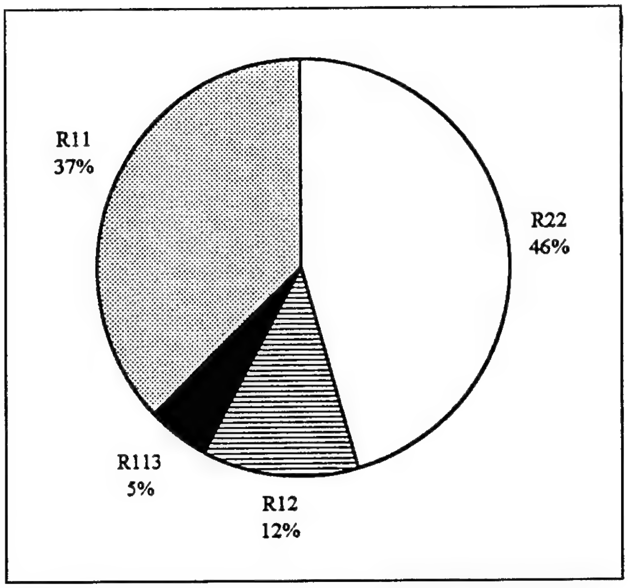

Figure 3. Percent of cooling provided by refrigerant type.

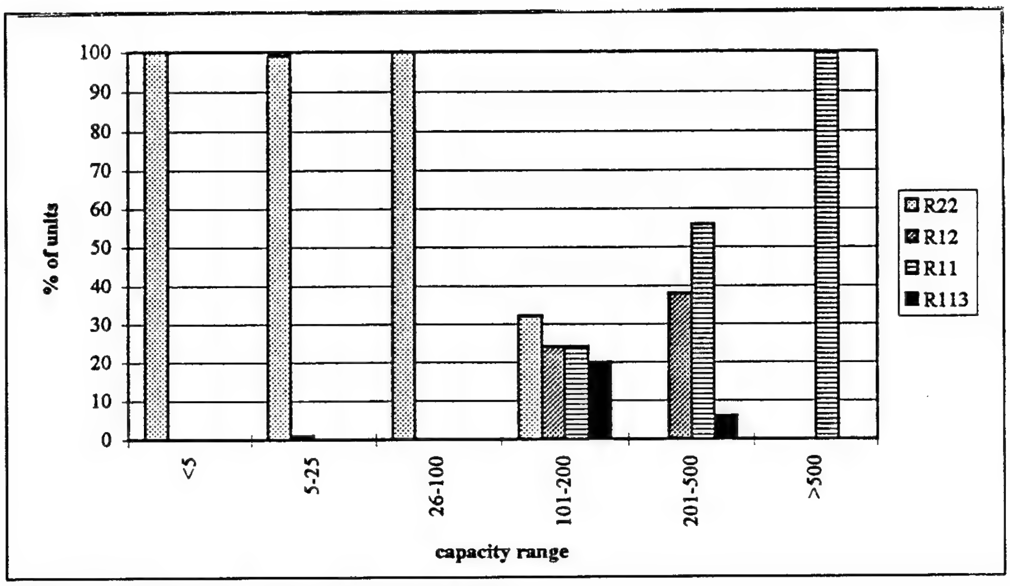

Figure 4. Refrigerant usage by capacity range.

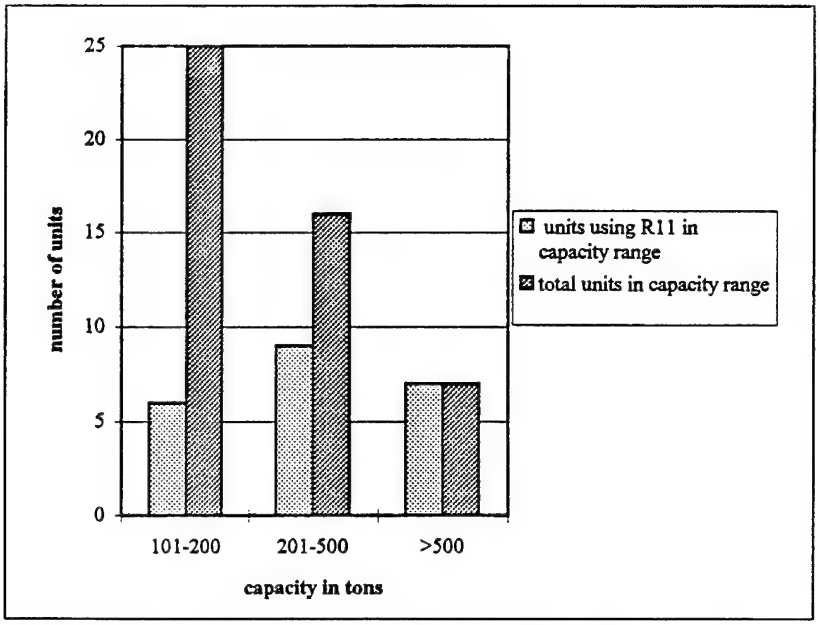

Figure 5. R-11 units versus total units in capacity range.

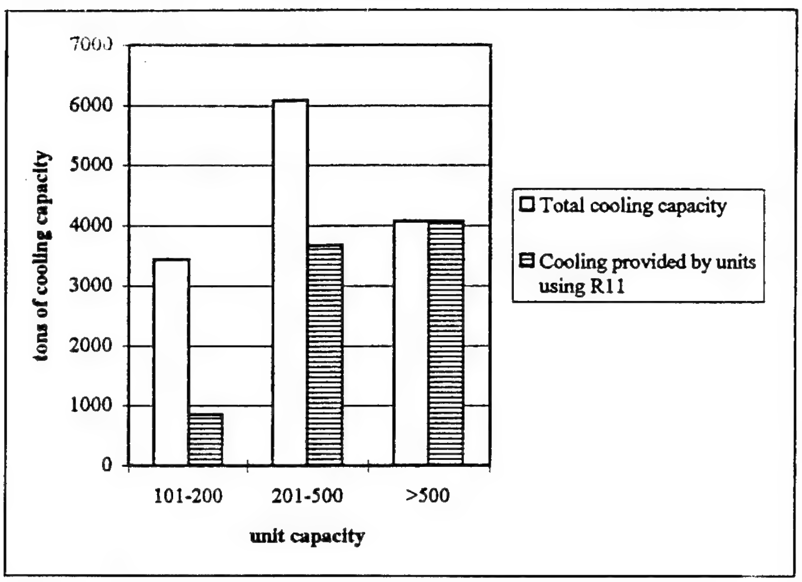

Figure 6. Total cooling capacity versus capacity provided by R-11 units.

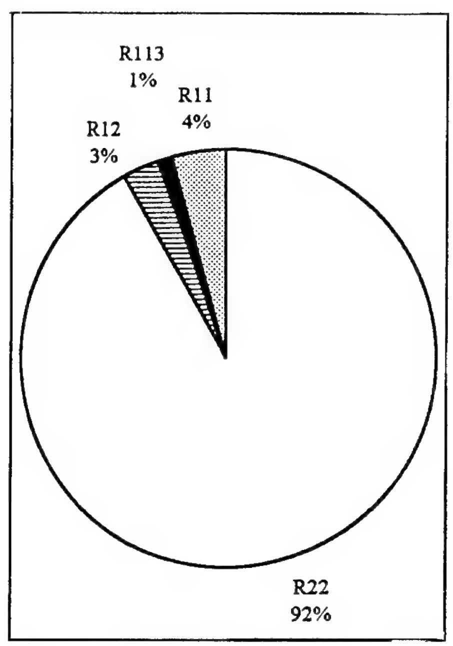

Figure 7. Percent of units by refrigerant type.

9 Conclusions and Recommendations

Conclusions

Objective No. 1: Reduce Energy Cost and Consumption

Review of Table I10 (Appendix I) indicates that economically viable conservation opportunities with significant potential exist at Fort Hood. For ECO-1, where chiller replacement was evaluated, 7 of 29 plants show simple payback periods less than 10 years. These plants, which represent nearly 50 percent of installed capacity, have combined savings of 32 percent in electrical demand, 26 percent in energy consumption, and 30 percent in annual operating costs. Their average simple payback periods are 7.9 years for capital costs related to energy conservation (net cost), and 8.7 years if all costs required to implement ECO-1 are considered (gross cost). The next group of 10 plants, which represent an additional 18 percent of installed capacity, show similar savings of 29 percent demand, 25 percent energy, and 28 percent annual operating costs, respectively, which yield combined payback periods of 13.9 years and 16.1 years, respectively, for net and gross costs. Estimated costs to implement ECO-1 for these 17 plants are $3,574,000 net and $4,002,000 gross, less a projected utility rebate of $178,500.

Replacement of chillers in the remaining 12 plants for energy conservation purposes (3 plants were excluded from consideration) will not be cost effective. Their replacement will largely depend on how the Directorate of Public Works (DPW) plans to cope with CFC refrigerant issues and their expected remaining useful life.

In terms of achieving basewide reductions of 20 percent in both energy cost and consumption, implementation of ECO-1 for the best 17 plants will reduce demand by 21 percent, energy consumption by 18 percent, and cost by 20 percent, from current levels for the 29 plants in this study. Because these savings are based on the assumption that existing chillers are operating in like-new condition, which is known not to be true, actual savings will exceed these predictions.

Implementation of the other primary ECO evaluated in this study, installation of variable speed drives for chillers, will reduce consumption for that group of chillers from 10 to 25 percent. However, costs will be reduced by only 4 to 8 percent because

these devices cannot reduce peak demand. Simple payback periods ranging from 6 to 13 years indicate that variable speed drives for chillers will likely survive life-cycle cost analysis.

Objective No. 2: Reduce Environmental Impact

The single most important environmental concern related to the operation of chiller plants involves the CFC refrigerant issue. Data sufficient to quantify the magnitude of this problem at the subject plants is not currently available. The only records provided were gross consumption of each refrigerant for the entire post. However, two of the refrigerants on the inventory would have limited use beyond central plant chillers, and speculation regarding their consumption rates would not be unfounded. Such analysis reveals the potential for alarming discharge rates of both compounds. For example, annual emissions of R-11 could exceed the legal limit by a factor of over 20. Evidence of significant efforts to reduce refrigerant emissions was not observed.

Implementation of ECO-1 will naturally assist in this regard because annual leakage rates of new chillers (typically well below 1 percent of their charge) will be far less than the machines they replace. Installation of new-technology rupture disks and high-efficiency purge units are recommended for the remaining chillers to conserve refrigerant, especially for R-11 and R-113 chillers, which lose most of their charge during normal purge cycles. For medium and high pressure chillers that operate with R-12 or R-22, improved maintenance procedures (which identify and repair offending machines) are suggested as the primary means of reducing undesirable emissions.

Objective No. 3: Document Analysis Techniques and Methodologies

Efforts to accomplish the third objective were successful in several areas. This report documents a modeling technique for chiller plants that allows rapid evaluation of alternatives with minimal user inputs. Suggested improvements are documented for known shortcomings. Also discussed are the difficulties encountered with the simplified approach used for this project, and recommendations are given that should improve the results of similar future projects.

Recommendations for Implementing ECOs

Appendix N presents the basewide plan for implementing chiller ECOs formulated by USACERL.

Upgrades that improve efficiency and accomplish alternate refrigerant objectives should be implemented in a plan based on results in Tables I10 (Appendix I) and L1 (Appendix L). A preferred plan will be outlined here. As was done for ECO-1, this plan is described by grouping buildings according to nine categories of work. Recommendations for categories one through seven, which include almost all work associated with chiller upgrades, are summarized in Table M1 (Appendix M).

Replace Chillers Immediately

Buildings are assigned to this category if net payback periods for replacement chillers are less than 18 years, and refrigerant conversions or retrofits are not available for chillers in these plants. On verification by life-cycle cost analyses, projects to replace chillers in the following buildings should proceed immediately: 5764, 27004, 41003, 50001, 50004, and 91001. The estimated cost for this category of work is $943,410 net and $1,074,327 gross, less a utility rebate of $33,615.

Perform Eddy Current Tests, Then Retrofit or Replace Chillers Accordingly

Chillers are included in this category if they have the potential for a conversion or retrofit that could cost substantially less than a new chiller. An eddy current test, along with all other tests appropriate for the type of potential upgrade, should be performed for chillers in the following buildings: Group 1, 29005, 39015, 39043, and 87018; Group 2, 121 and 42000; Group 3, 5792, 14020, and 14023; Group 4, 7051, 36006, and 50004 (newest 1 of 3). Groups 1, 2, and 3 contain retrofit candidates organized by refrigerant type and potential payback period. Group 4 includes all conversion candidates in this study. Eddy current testing of all machines is estimated to cost $17,000. If testing reveals that a machine is not suitable for continued long-term service on a retrofit or conversion, that machine should be replaced. Total costs to replace all chillers in this group, except for the chiller that was already replaced in Building 50004, are estimated to be $2,526,740 net and $2,788,233 gross, less a utility rebate of $144,246. However, if all subject chillers are found to be suitable for retrofit or conversion, capital costs could be reduced by approximately 35 percent. Costs for this scenario are estimated to be $1,571,485 net and $1,832,978 gross, less a utility rebate of $144,246.

Each building in Group 1 contains two large R-11 centrifugal chillers. A retrofit for these candidates could reduce installation costs by nearly 40 to 50 percent compared to new equipment. Buildings 29005 and 39015 may be more likely candidates because capacity reductions appear acceptable, and this may be a factor in equipping Trane chillers with York compressors. This group should be tested first.

Chillers in Buildings 121 and 42000 of Group 2 are also R-11 retrofit candidates in which capacity reductions appear acceptable, but potential cost savings for retrofit versus replacement fall to the range of 20 to 30 percent.

Buildings in Group 3 contain three of the five R-113 machines in the study. Although predicted capital savings for retrofit compared to replacement are 30 percent, the possibility for successful retrofit installations in these buildings is slim because equal or increased capacity is indicated. In addition, preliminary investigation for suitable compressors should precede testing of these chillers.

The four chillers in Group 4 are conversion candidates that offer savings in capital cost, compared to new equipment, of up to 80 percent. Unfortunately, the 10 to 15 percemt loss in capacity that accompanies these refrigerant conversions will require relocation of all four chillers to buildings in which they could meet peak cooling loads. Both chillers in Building 7051 could be relocated to Building 7050; and one chiller from each of Buildings 36006 and 50004 could be relocated to Buildings 21002 and 194, respectively. Also note that capacity reductions will cause corresponding reductions in chiller efficiencies, but simple payback periods ranging from 5 to 13 years for this group appear acceptable.

Convert and Relocate Chillers

The outcome for existing chillers in Buildings 194, 7050, and 21002 should depend on the results of eddy current testing of chillers slated for relocation to these buildings. Potential conversion and relocation candidates are discussed in the preceding paragraph. When candidates are unsuitable for conversion, new chillers should be installed in Buildings 7050 and 21002 and the chiller in Building 194 should remain in service. The cost to convert and relocate four chillers is an estimated $120,000 net and $206,214 gross. If three new chillers are installed, estimated costs are $364,911 net and $436,455 gross, less a utility rebate of $8,890.

Refurbish Remaining Chillers for Refrigerant Conservation

Chillers in the preceding categories that are not replaced should be refurbished with new rupture disks and high-efficiency purge units when applicable. Serious "leakers" should receive cost-effective repairs, as should any chillers for which light-duty maintenance would improve operating efficiency. In addition, chiller rooms in this category should be upgraded to conform with current recommendations and regulations. At the minimum, this category includes Buildings 135, 410, 2805, 28000, 31008, 34008, 36009, and 36014. Costs to install rupture disks and purge units are estimated to be $8,900 for these buildings. Costs for other types of repair work could

not be quantified. Mechanical room upgrades are estimated to cost $49,558 for five of the seven buildings in which such work is indicated. Separation of boilers and chillers in Buildings 31008 and 34008 cannot be accomplished without relocating the one chiller in each plant to a new extension of the mechanical room. The cost to construct the additions is an estimated $23,752 each. Costs to relocate chillers, piping, etc. are not included.

Compare Replacement, Retrofit, Conversion, and Maintenance Options

Building 36000, the main hospital and final plant to be discussed, is in a separate category to illustrate the economics of alternatives for multiple-chiller plants. At the minimum, one of three existing chillers, which was out of service during all site visits, appears to require replacement. The replacement chiller could be the same size, or it could be upsized to allow refrigerant conversion of the two remaining R-11 chillers, which are relatively new and excellent candidates for this type of upgrade. The study assumed a 557-ton replacement chiller for this purpose. The alternatives of installing one new machine or installing one new machine and converting the other two was compared to replacing all three chillers. Net simple payback periods are 9.9, 43.3, and 21.5 years, respectively. Costs are shown on Table M1 (Appendix M). For this plant, it is recommended that only one new machine be installed; the other two machines should receive attention to eliminate leaks that are documented as excess purge cycles on their control panels. Being relatively new does not guarantee that these chillers are in good condition, but they do seem to be. Payback periods greater than 20 years to replace them should be sufficient incentive to provide excellent maintenance to these machines.

Manage Refrigerant Inventories

Other potential benefits of scenarios described here are not immediately obvious. For example, up to six R-12 chillers could be replaced in the short term as described here. Disposition of these chillers would yield 4900 lb of refrigerant, which would create a stockpile for the remaining five R-12 chillers that have a combined charge of 2300 lb. If the remaining chillers were maintained so their annual leakage rates did not exceed the legal limit of 15 percent of system charge, the stockpile would last for at least 14 years. Also, at actual prices paid during 1993 for R-12, that stockpile represents over $36,000. A similar analysis for R-11 would reveal an even larger stockpile. Management of these inventories will become increasingly important as CFC refrigerants become scarce and prices rise accordingly.

Install Variable Speed Drives for Suitable Chillers

Energy savings predicted in this study should be confirmed with factory simulations for 13 buildings in which the lead chiller was modeled with a variable speed drive. The subject buildings listed in Tables J3 (Appendix J), and repeated in Table M1 (Appendix M), include 11 new lead chillers and 2 existing screw chillers. Installation of 13 drives is estimated to cost $605,536.

Replace Chilled and Condenser Water Pump Motors

Bulk purchase and installation of premium-efficiency motors will likely increase the cost effectiveness of this measure. For all buildings in which existing pump motors would not be affected by work related to chiller replacement, these motors should be replaced. An overall listing of pump motors is available from Tables D4 and D5 (Appendix D). This initial listing should be edited to exclude all existing motors that would be affected by chiller replacement. Discussions earlier in this chapter and in Chapter 5 for ECO-1 need to be consulted during this editing process. In addition, the horsepower rating of replacement motors should be determined with due respect to the large number of pumping circuits in which flow deviates excessively from specified values. The horsepower rating of the replacement motors should be determined after required corrections have been made to the piping system. Flow rates then should be set in accordance to manufacturers specifications. The estimated cost for this upgrade should not exceed $142,000.

Implement Demand Limiting

Chiller replacement recommended under ECO-1 would affect 70 percent of the demand created by all chillers in this study. All new and upgraded chillers should be equipped to incorporate demand limiting as installation of the basewide energy monitoring system progresses. The additional cost to include this feature with new chillers is negligible compared to potential savings.

Recommendations for Revising Study Methodologies

Theory

This report presents the assessment of potential for gross energy savings at chiller plants serving Fort Hood. This study documents that potential does exist. Also, there is potential for learning from this experience.

Two of the most time-consuming efforts involved in this type of work are establishing a design cooling load and determining the actual operating efficiency of existing equipment. Answers to the question, "To what extent do variations in these two values affect the results of life-cycle cost analyses?", should provide insight for future work. A sensitivity analysis is recommended for this purpose.

The work would involve preparation of at least four sets of energy simulations, cost estimates, and possibly life-cycle cost analyses for either the buildings in this study or a generic group targeted for other objectives, i.e., different types of buildings or incremental sizes of plants. The simulations would model design cooling loads projected from field measurements, and design cooling loads equal to rated capacities of existing equipment. Each of these conditions would be modeled with like-new chiller efficiencies and with reduced efficiencies to account for aging equipment and/or poor maintenance practices. With another data set already available from this report, results should be analyzed for correlations. This work is believed necessary because results in this study are based, in part, on data available from a previous study. Such will not be the case for Army-wide energy conservation investigations.

Application

Some portion of field investigation time was used ineffectively to obtain measurements that were ultimately determined to be of little value. Therefore, work during initial visits should be limited to obtaining nameplate information and an overall understanding of peculiarities at the site. Potential locations for measurement instrumentation, including flow meters, should be documented as should other deficiencies that require corrective work to make follow-up visits as productive as possible. Initial site visits should be scheduled to allow time for corrective work to be completed before the next cooling season. It is not essential that equipment be operating during these visits.

The next step would necessarily involve contacting manufacturers for design specifications. This is a time-consuming endeavor. One must provide written requests to the proper departments of each equipment manufacturer. Manufacturering companies generally are organized so different offices support different product lines. Hence, numerous phone call facsimile transmissions (faxes) are required to request information. Even more calls/faxes are required to ensure delivery of information. (Generally manufacturers recognize that responding to requests for information from consultants/researchers undertaking energy efficiency studies rarely results in equipment sales.)

Availability of data from manufacturers on the specific chiller in question will influence work from this point. If rated capacities and like-new efficiencies are sufficient to provide the intended results, analysis work can continue most efficiently. For this work, calculated loads available from a previous study were used with original equipment efficiencies. If more detailed results are required, additional resources must be allocated for this work. These resources must be consistent with the level of effort required to develop better information and the degree of improvement it provides.

Two notes about field measurements will conclude this report. Snapshot views obtained from one-time measurements must be used with caution unless details that qualify these measurements also are obtained and documented. In addition to recording dates, times, outside air temperatures, and solar conditions, information that describes the status of buildings served by the plants is necessary. The preferred method for obtaining more reliable information involves continuous monitoring of key variables for periods of at least 1 week. For sites not equipped with this capability, such instrumentation could be installed permanently and used to monitor the performance of subsequent ECOs or, for reduced capital cost, a fair portion of the instrumentation could be rotated to other buildings.

References

Cited

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2. Energy Engineering Analysis Program (EEAP), *Boiler/Chiller Plant Study, Fort Hood, Texas* (Romine, Romine and Burgess, Inc., August, 1991).

3. American Society of Heating, Refrigerating and Air Conditioning Engineers, *Handbook of Heating, Ventilating, and Air-Conditioning Systems and Equipment* (American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. [ASHRAE], 1992).

4. *Commercial/Industrial Demand-Side Management Programs* (Texas Utilities Electric Company, 1993).

5. *Means Mechanical Cost Data, 1993* (R.S. Means Company, Inc., 1993).

6. *Means Mechanical Cost Data, 1994* (R.S. Means Company, Inc., 1994).

7. *Means Square Foot Costs, 1993* (R.S. Means Company, Inc., 1993).

8. Air-Conditioning and Refrigeration Institute, *Standard 550-77* (Air-Conditioning and Refrigeration Institute [ARI], Arlington, VA, 1992).

9. American Society of Heating, Refrigerating and Air-Conditioning Engineers, *Safety Code for Mechanical Refrigeration*, ANSI/ASHRAE 15-1992 (ASHRAE, 1992).

10. American Society of Heating, Refrigerating and Air-Conditioning Engineers, *Handbook of Fundamentals* (ASHRAE, 1993).

11. *Refrigerant Recycling and the Prohibition on Venting, Summary of Final Rule* (U.S. Environ mental Protection Agency, April 1993).

Uncited

Refrigeration System Equipment Room Design, Applications Engineering Manual, REF-AM-3 (The Trane Company, August 1992).

Technical Manual (TM) 5-785, *Facility Design and Planning—Engineering Weather Data* (Headquarters, Department of the Army [HQDA], Washington, DC, 1 July 1978), pp 3-374 and 3-375.

York Products and Services for CFC Management, 2nd Edition, Form 50.60-MG2 (York International Corp., June 1992).

Appendix A: CFC Refrigerant Issues

Introduction

Two atmospheric scientists from the University of California at Irvine developed a theory in 1974 that chloroflourocarbons (CFCs) and hydrochloroflourocarbons (HCFCs) were depleting the earth's ozone layer. Their theory maintains that stable CFC or HCFC compounds migrate into the upper atmosphere where they are bombarded with solar radiation. That exposure to radiation leads to the breakdown of the CFC or HCFC molecule, which releases chlorine ions. The free chlorine ions react with ozone to create chlorine monoxide. To prevent this last reaction from destroying the ozone layer, the United Nations (UN) became involved to eliminate the use of CFCs and HCFCs. Many of the traditional refrigerants used in the air-conditioning industry are affected by this issue. CFCs include R-11, R-12, and R-113. HCFCs include R-22.

Montreal Protocol and Clean Air Act

The ozone depletion theory grew into a raging environmental issue that was addressed by the UN world community of 11 industrial nations. The results of the first UN meeting (known as the Montreal Protocol) and two subsequent meetings are agreements to phase out production of all CFC and HCFC compounds. In 1992 the Bush administration accelerated the deadline for eliminating CFC production imposed by the Montreal Protocol. This new policy is called the Clean Air Act. Updated deadlines established by the Clean Air Act include:

- January 1, 1995—ban production of all CFC compounds
- January 1, 2020—ban production of all HCFC compounds.

Availability of CFCs

Deadlines imposed by the Clean Air Act do not prevent manufacturers of CFC compounds from stopping production before the deadline. DuPont, the world's largest producer of CFCs, has announced their decision to cease production of this

material by sometime early in 1994*. Reduced availability of CFCs from previous cutbacks already has affected costs, and this trend will worsen. Prices for R-11, which had been relatively stable from 1990 to 1991, increased between 50 and 100 percent by 1993. Various sources project future increases upward from 100 percent to the end of the decade, but variables such as excise tax and the effect of conversions/retrofits make these predictions difficult. At any rate, maintenance practices should improve and focus on reducing the loss of CFCs for legal, environmental, and economic reasons.

Alternative Refrigerants

Newly developed refrigerants R-123 and R-134a will replace R-11 and R-12, respectively. These new compounds will join with R-22 to provide at least three refrigerant choices for the next 25 years. R-123 is an HCFC-based refrigerant designed for low pressure operation, and R-134a is a hydroflourocarbon-based (HFC) refrigerant designed for medium pressure machines. Of the three choices, note that both R-123 and R-22 are scheduled to be eliminated by the year 2020. R-134a does not contribute to problems with the ozone layer because it does not contain chlorine, so R-134a has an unlimited future in this respect. However, this refrigerant may face potential regulations to control global warming. An acceptable substitute for R-113 has not been developed. Therefore, it is critical that machines using these refrigerants be well maintained because, with no alternative refrigerant available, these machines will be inoperable when the last of the R-113 is gone. Equipment designed to operate with the properties of this refrigerant will need a major upgrade to remain in service, or this equipment will have to be replaced.

The environmental benefits of alternate refrigerants are provided at the expense of some efficiency compared to traditional refrigerants. Theoretical performance at 40 °F evaporating and 100 °F condensing is listed in Table A1[10]. These values indicate why R-11 has been the refrigerant of choice up to this time.

USEPA Regulations

The USEPA established refrigerant recycling requirements under Section 608 of the Clean Air Act Amendments of 1990. Highlights of Section 608, including final regulations signed by the Administrator on April 23, 1993, and highlights of the

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* DuPont issued a statement in December 1994 (#231697D), which stated in part, "Phaseout of production and consumption of CFCs, methyl chloroform and tetrachloride by January 1, 1996."

Table A1. Theoretical performance of refrigerants.

Refrigerant	Theoretical Performance (hp/ton)
R-11	0.636
R-113	0.710
R-123	0.663
R-12	0.689
R-134a	0.712
R-22	0.696

prohibition on venting CFCs that became effective on July 1, 1992, are outlined here[11]. The majority of requirements contained in Section 608 became effective in mid-1993.

- Air-conditioning and refrigeration equipment service and disposal practices shall maximize recycling of ozone-depleting compounds (CFCs and HCFCs).
- Contractors, service technicians, reclaimers, and recovery and recycling equipment shall all be certified.
- Refrigerants shall be sold only to and by certified technicians.
- Substantial leaks in air-conditioning and refrigeration equipment with a charge greater than 50 lb shall be repaired, or a retrofit or retirement plan shall be submitted to the USEPA within 30 days of the violation. Annual leakage rates of 35 percent of system charge for industrial process and commercial refrigeration equipment and 15 percent of system charge for comfort cooling equipment define the maximum permissible rates of discharge.

Owners of equipment with a charge greater than 50 lb must maintain a record of all refrigerant added to such equipment during service procedures. These records shall be presented to the USEPA on request.

Knowingly venting ozone-depleting refrigerant compounds into the atmosphere while maintaining, repairing, or disposing of air-conditioning or refrigeration equipment is unlawful and subject to a fine of $25,000 per day per violation. Circumstances of certain discharges may be evaluated before enforcement is pursued. The USEPA places a high priority on responding to tips of such acts.

Safety Code for Mechanical Refrigeration

A safety code for mechanical refrigeration (ANSI/ASHRAE 15-1992)[9] was approved by the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) on July 2, 1992, and by the American National Standards Institute (ANSI) on October 26, 1992. This code sets forth recommended guidelines to promote the safety of persons and property located on or near premises where refrigeration facilities are located. These guidelines become legally binding upon adoption by authorities having jurisdiction, but they should be followed in any event as good engineering practice. Highlights of this standard as they apply to mechanical rooms at Fort Hood are outlined here[9]. However, the standard shall be consulted for a complete understanding of the detailed requirements that are impractical to include in this report. Also, requirements of several other codes and standards, such as the Uniform Building Code and National Fire Codes, normally apply to refrigeration systems and associated structures.

Characteristics of chiller plants in this study, as defined by ANSI/ASHRAE 15-1992[9], are listed in Table A2. Requirements for all refrigerants of concern are generally the same, except for those based on quantity, and those that require different monitoring for R-123 because of its higher toxicity.

Table A2. ANSI/ASHRAE 15-1992[9] Classifications.

Characteristic	Classification
Occupancy	Commercial (some public assembly also)
Refrigerant Group	A1 for R-11, 113, 12, 134a and 22 (No Flame Propagation, Lower Toxicity)
	B1 for R-123 (No Flame Propagation, Higher Toxicity)
Refrigerant System	Indirect closed
System Probability	High for mechanical rooms containing air handling units and ductwork
	Low for most all others

General Construction

Mechanical rooms that contain refrigeration equipment shall be separated from adjacent occupied areas by wall, floor, and ceiling assemblies that meet requirements for 1-hour, fire-resistive construction. Access directly outdoors shall be provided. All

penetrations for ductwork, piping, conduit, etc. shall be sealed tight; no other types of openings are permitted.

At least one self-contained breathing apparatus shall be available outside the entrance to the room. A back-up apparatus is strongly recommended.

Combustion Air

If a boiler and refrigeration machine are located in the same enclosed space, combustion air shall be drawn into the boiler directly from outdoors. The intent is to prevent stray refrigerant from entering the boiler because resultant products of combustion are dangerous to humans and corrosive to equipment. Practical solutions for most instances involve isolating the refrigeration machine within a dedicated enclosure.

No other equipment with an open flame that can draw combustion air from within the room is permitted.

Ventilation

Rooms that contain refrigeration equipment shall be equipped with a mechanical ventilation system (including one or more power-driven exhaust fans) designed to provide two modes of operation, normal and purge.

The minimum flow rate for purge ventilation shall be calculated with the following equation:

$$Q = 100 * G^{0.5} \qquad \text{[Eq A1]}$$

where: Q = flow rate in cubic feet per minute

G = mass of refrigerant in pounds contained in the largest system, any part of which is located in the equipment room.

Minimum flow rates for normal ventilation shall satisfy two criteria: provide the larger of 0.5 cfm per square foot of floor area or 20 cfm per occupant; and limit, when desired by the occupant, the maximum temperature rise due to all heat-producing equipment to 18 °F.

Normal and purge ventilation modes may be provided by the same equipment. Capacity reduction methods such as multiple fans or multispeed motors are acceptable.

Make-up and discharge openings shall be located to prevent recirculation or cause potentially dangerous conditions.

If the enclosure that contains refrigeration equipment is located at least 20 ft from the nearest opening into another building, requirements for both ventilation modes may be satisfied by natural ventilation. The minimum free area of opening(s) in the enclosure shall be calculated with the following equation:

$$A = G^{0.5} \qquad \text{[Eq A2]}$$

where: A = minimum free area in square feet

G = mass of refrigerant in pounds contained in the largest system, any part of which is located in the equipment room.

Opening(s) shall be located with due respect to the difference in density between air and the subject refrigerant.

Controls

Remote pilot control of mechanical equipment in the mechanical room shall be provided immediately outside the mechanical room for emergency shutdown purposes. Ventilation fan control shall be provided at the same location and shall be installed on a separate circuit. If manual control is provided for the normal ventilation mode, a sign shall warn that operation is required during all occupied periods.

Monitoring and Alarms

Monitoring and alarm requirements vary depending on the refrigerant group classification. The procedure that determines this classification was established by The American Society of Mechanical Engineers (ASME). The degree of flammability is signified by an increasing numerical value (1, 2, or 3); the degree of toxicity is signified by a letter (A or B).

An oxygen sensor, set to alarm at levels less than 19.5 percent by volume, shall be installed for Group A1 refrigerants. A refrigerant vapor sensor, set to alarm at values no greater than the corresponding threshold limit value (TLV), shall be installed for refrigerants in all other groups (except ammonia). This type of sensor is an acceptable substitute for the oxygen sensor required for Group A1 and is recommended. The vapor-type sensor is capable of detecting a refrigerant leak much

sooner than an oxygen sensor, which could minimize the loss of the refrigerant charge.

When the measured condition reaches a predetermined setpoint, the purge mode ventilation system shall be energized and an alarm shall be initiated.

Appendix B: Organizations Contacted

Aurora Pump (pump manufacturer)
800 Airport Road
North Aurora, IL 60542
708-859-7000

Beckwith & Kuffel, Inc.
5930 First Avenue South
Seattle, WA 98108-3248
206-767-6700
manufacturer's representative for Goulds Pumps, Inc. (pump manufacturer)

G.J. Campbell & Associates
11613 Rainer Avenue South
Seattle, WA 98178
206-772-111
manufacturer's representative for Baltimore Aircoil Company (cooling tower manufacturer)

Carrier Corp. Building Systems & Services
655 South Orcas, #100
Seattle, WA 98108
206-439-0097
manufacturer's representative for Carrier Corp. (chiller manufacturer)

Griffin Commercial Parts, Inc.
6031 Airport Way South
Seattle, WA 98108
206-763-8921
manufacturer's representative for Dunham-Bush (chiller manufacturer)

Larry Harrington Company, Inc.
P.O. Box 4326
Portland, OR 97208
503-228-4324
manufacturer's representative for ITT Bell & Gossett (pump manufacturer)

Havens Cooling Towers, Inc. (cooling tower manufacturer)
P.O. Box 213
Sunrise Beach, MO 65079
314-374-4546

MagneTek (motor manufacturer)
333 Route 46
Fairfield, NJ 07004
800-622-2924

Marathon Electric Manufacturing Corp. (motor manufacturer)
P.O. Box 8003
Wausau, WI 54402
715-675-3311

Natkin Service Company (building systems service company)
12815 N.E. 124th Street, Suite L
Kirkland, WA 98034
206-821-8700

Norby Company
3805 108th N.E.
Bellevue, WA 98004
206-624-2411
manufacturer's representative for Snyder General Corp. (chiller manufacturer)

Olympic Engineered Sales, Inc.
P.O. Box 549
Bellevue, WA 98009
206-454-0701
manufacturer's representative for The Marley Cooling Tower Company

PACO Pumps, Inc. (local PACO pump representative)
3215 South 116th Street, #109
Seattle, WA 98168
206-433-2600

Pumptech, Inc.
13251 Northup Way
Bellevue, WA 98005-2009
206-644-8501
manufacturer's representative for Peerless Pump Company

A.D. Reid Northwest, Inc.
P.O. Box 24203
Seattle, WA 98124
206-624-2183
manufacturer's representative for EVAPCO, Inc. (cooling tower manufacturer)

Roberts Trane Company
2021 152nd Avenue, NE
Redmond, WA 98052
206-643-4310
manufacturer's representative for The Trane Company (chiller manufacturer)

Scot Division of Ardox Corp. (pump manufacturer)
6437 Pioneer Road
Cedarburg, WI 53012
414-377-7000

Taco, Inc. (pump manufacturer)
1160 Cranston Street
Cranston, RI 02920
401-942-8000

Texas Utilities Electric Company (electric utility company)
P.O. Box 100001
Dallas, TX 75310-0001
214-791-2888

Tri-Thermal, Inc. (cooling tower representative)
P.O. Box 52752
Tulsa, OK 74152
918-834-3600

Triangle Pumps, Inc.
P.O. Box 950
Clackamas, OR 97015
206-251-9666
manufacturer's representative for the following motor and pump manufacturers: Aermotor, Weinman, Midland, Mueller

U.S. Electrical Motors (motor manufacturer)
58 Robinson Boulevard, Suite C
Orange, CT 06477
800-243-2700

Washington Air Reps, Inc.
3290 146th Place SE, Building A
Bellevue, WA 98007
206-562-1150
manufacturer's representative for York International Corp. (chiller manufacturer)

York International Corp. (Seattle office of chiller manufacturer)
221 S.W. 41st Street
Renton, WA 98055
206-251-9145

Appendix C: Listing of Plants and Buildings Served

APPENDIX C

Table C-1. Chiller Plants and Buildings Served

TRIP NOTES	PLANT NO.	PLANT BLDG NO	SERVED BLDG NO	BUILDING NAME
	1	121		GENERAL PURPOSE ADMIN
10	2	135		POST EXCHANGE OFFICE
	3	194		NON-COM DINING
	4	334 DX		THEATRE
	5	410		DIVISION HQ
	6	2805		RECREATION CENTER
	7	5764		OFFICER DINING
	8	5792		BOQ
8			5786	BOQ
			5788	BOQ
			5790	BOQ
	9	7050		TRAINING FLIGHT SIMULATOR
	10	7051		TRAINING FLIGHT SIMULATOR
1	11	9418		EM BARRACKS W/ ADMIN & SUPP
1			9210	EM BARRACKS W/ ADMIN, SUPP & DINING
			9211	EM BARRACKS W/ ADMIN, SUPP & DINING
			9213	EM BARRACKS W/ ADMIN, SUPP & DINING
			9414	EM BARRACKS W/ ADMIN, SUPP & DINING
			9419	EM BARRACKS W/ ADMIN & SUPP
			9420	EM BARRACKS W/ ADMIN & SUPP
			9421	EM BARRACKS W/ ADMIN & SUPP
			9422	EM BARRACKS W/ ADMIN & SUPP
			9423	EM BARRACKS W/ ADMIN & SUPP
			9424	EM BARRACKS W/ ADMIN & SUPP
			9425	EM BARRACKS W/ ADMIN & SUPP
6	12	10006		EM BARRACKS W/ ADMIN & SUPP
			10001	EM BARRACKS W/ ADMIN & SUPP
			10002	EM BARRACKS W/ ADMIN & SUPP
			10003	EM BARRACKS W/ ADMIN & SUPP
			10004	EM BARRACKS W/ ADMIN & SUPP
			10005	EM BARRACKS W/ ADMIN & SUPP
			10007	EM BARRACKS W/ ADMIN & SUPP
			10008	EM BARRACKS W/ ADMIN & SUPP
			10009	EM BARRACKS W/ ADMIN & SUPP
			10010	EM BARRACKS W/ ADMIN & SUPP
			10011	EM BARRACKS W/ ADMIN & SUPP
			10016	EM BARRACKS W/ ADMIN & SUPP
			10018	EM BARRACKS W/ ADMIN & SUPP
			10020	EM BARRACKS W/ ADMIN & SUPP
			10021	EM BARRACKS W/ ADMIN & SUPP
			10022	EM BARRACKS W/ ADMIN & SUPP
	13	14020		EM BARRACKS W/ ADMIN, SUPP & DINING
			14019	EM BARRACKS W/ ADMIN, SUPP & DINING
	14	14023		EM BARRACKS W/ ADMIN, SUPP & DINING
			14022	EM BARRACKS W/ ADMIN, SUPP & DINING
	15	21002		EM DINING
			21001	GENERAL PURPOSE ADMIN
			21003	EM BARRACKS W/ ADMIN & SUPP
	16	27004		EM DINING
2			27002	EM BARRACKS W/ ADMIN & SUPP
			27006	EM BARRACKS W/ ADMIN & SUPP
	17	28000		DIVISION HQ
	18	29005		CENTRAL ENERGY PLANT
			29004	ADMIN & SUPP
			29006	EM DINING
3			29007	ADMIN & SUPP
			29008	EM BARRACKS
			29009	EM BARRACKS
			29010	EM BARRACKS
			29011	ADMIN & SUPP
			29013	GENERAL PURPOSE ADMIN
			29014	DIVISION HQ
			29015	GENERAL PURPOSE ADMIN
			29016	ADMIN & SUPP
			29019	EM BARRACKS
			29020	EM BARRACKS
			29021	EM BARRACKS
			29022	EM BARRACKS
7	19	31008		EM DINING
			31007	EM BARRACKS W/ ADMIN & SUPP
			31009	EM BARRACKS W/ ADMIN & SUPP
			31010	GENERAL PURPOSE ADMIN
	20	34008		EM DINING
			34006	EM BARRACKS W/ ADMIN & SUPP
			34010	EM BARRACKS W/ ADMIN & SUPP

APPENDIX C

Table C-1. Chiller Plants and Buildings Served

TRIP NOTES	PLANT NO.	PLANT BLDG NO	SERVED BLDG NO	BUILDING NAME
5	21	36000		MAIN HOSPITAL
	22	36006		BOQ
	23	36009		EM DINING W/ ADMIN
			36007	EM BARRACKS
			36008	EM BARRACKS
9	24	36014		DENTAL CLINIC
	25	39015		CENTRAL ENERGY PLANT
			39001	BATTALION ADMIN
			39002	BATTALION ADMIN
			39004	EM BARRACKS
			39005	EM BARRACKS
			39006	EM BARRACKS
			39007	EM BARRACKS
4			39008	FITNESS CENTER
			39009	DIVISION HQ
			39010	UNIT CHAPEL
			39011	TROOP MEDICAL CLINIC
			39012	EM BARRACKS
			39013	EM BARRACKS
			39014	POST EXCHANGE OFFICE
			39016	EM DINING
			39017	EM BARRACKS
			39020	ADMIN & SUPP
			39021	ADMIN & SUPP
			39022	ADMIN & SUPP
	26	39043		CENTRAL ENERGY PLANT
			39030	GENERAL PURPOSE ADMIN
			39031	EM BARRACKS
			39032	EM BARRACKS
			39034	EM BARRACKS
			39035	EM BARRACKS
			39036	EM BARRACKS
			39037	EM BARRACKS
			39038	EM BARRACKS
			39039	EM BARRACKS
			39040	EM BARRACKS
			39041	EM DINING
			39042	ADMIN & SUPP
			39044	ADMIN & SUPP
			39045	GENERAL PURPOSE ADMIN
			39050	ADMIN & SUPP
			39051	EM BARRACKS
			39052	EM BARRACKS
			39053	EM BARRACKS
			39054	ADMIN & SUPP
	27	41003		EM DINING
			41002	EM BARRACKS W/ ADMIN
	28	42000		NON-COM DINING
	29	50001		COMMISSARY
	30	50004		POST EXCHANGE RETAIL STORE
	31	87018		CENTRAL ENERGY PLANT
			87003	GENERAL PURPOSE ADMIN
			87004	ADMIN & SUPP
			87005	DIVISION HQ
			87006	TROOP MEDICAL CLINIC
			87007	EM BARRACKS
			87008	POST EXCHANGE OFFICE
			87009	BATTALION ADMIN
			87010	FITNESS CENTER
			87011	BATTALION ADMIN
			87012	EM BARRACKS
			87013	EM BARRACKS
			87014	ADMIN & SUPP
			87015	EM BARRACKS
			87016	ADMIN & SUPP
			87017	EM DINING
			87019	ADMIN & SUPP
			87020	EM BARRACKS
			87021	EM BARRACKS
			87022	EM BARRACKS
	32	91001		EM BARRACKS W/ ADMIN, SUPP & DINING
11	33	91002		ADMIN & SUPP

APPENDIX C

Table C-1. Chiller Plants and Buildings Served

	TRIP NOTES
1	PLANT 9418 WAS PARTIALLY DISMANTLED DURING TRIP 1 BECAUSE REPLACEMENT PLANT WAS SCHEDULED TO COME ON-LINE. HOWEVER,CONSTRUCTION OF REPLACEMENT PLANT WAS DELAYED, SO EXISTING PLANT IS BEING REBUILT. PLANT 9418 AND ASSOCIATED BUILDING 9210 WERE REVISITED BRIEFLY DURING TRIP 2, BUT SINCE THE PLANT IS BEING DEMOLISHED AND DORMITORY IS BEING REFURBISHED, NO DATA WAS COLLECTED.
2	BUILDING 27006 WAS INSPECTED IN LIEU OF BUILDING 27002.
3	BUILDING 29007 WAS NOT INSPECTED BECAUSE MAINTENANCE PERSONNEL REPORTED IT SIMILAR TO BUILDING 29004.
4	BUILDING 39008 IS NOT SERVED WITH CHILLED WATER.
5	INSPECTION OF PLANT 36000 WAS APPROXIMATELY 75% COMPLETE AFTER TRIP 1. PLANT 36000 WAS REVISITED BRIEFLY DURING TRIP 2, BUT SINCE THIRD CHILLER WAS OUT OF SERVICE AND SCHEDULED TO BE REPLACED, NO ADDITIONAL DATA WAS COLLECTED DURING THIS VISIT.
6	PLANT 10006 IS REPLACEMENT PLANT THAT IS NOT YET ON-LINE. INSPECTION DURING TRIP 1 CONSISTED OF BRIEF WALK-THRU TO OBSERVE A STATE-OF-THE-ART INSTALLATION FOR THE POST. FURTHER INSPECTION OF THIS PLANT FOR ENERGY CONSERVATION PURPOSES IS NOT WARRANTED. PLANT 10006 WAS REVISITED BRIEFLY DURING TRIP 2 TO OBTAIN PHOTOGRAPHS ONLY. PLANT SEEMED TO BE ON-LINE FOR TESTING.
7	PLANT 31008 WAS OUT SERVICE DURING TRIP 1 BECAUSE COOLING TOWER WAS RECENTLY DAMAGED BY LIGHTNING. THEREFORE, INSPECTION COULD NOT BE PERFORMED AHEAD OF SCHEDULE.
8	BUILDING 5790 WAS INSPECTED IN LIEU OF BUILDING 5786.
9	PLANT 36014 WAS FOUND TO CONTAIN TWO CHILLERS, ONE OF WHICH WAS INTENDED TO OPERATE WITH SOLAR ENERGY EQUIPMENT. THIS CHILLER IS NOT IN SERVICE.
10	PLANT 135 WAS FOUND TO CONTAIN TWO CHILLERS.
11	PLANT 91002 WAS RECENTLY UPGRADED WITH ALL NEW EQUIPMENT EXCEPT FOR THE CHILLER, WHICH WAS REPORTED TO REQUIRE EXCESSIVE MAINTENANCE TO REMAIN OPERATIONAL. UPGRADE APPEARED NEARLY COMPLETE. NO DATA WAS COLLECTED.
12	PLANT 5764 WAS FOUND TO CONTAIN TWO CHILLERS. THE SECOND, AIR-COOLED, CHILLER WAS DISCOVERED AFTER ALL TRIPS WERE COMPLETED, SO NO DATA WAS COLLECTED.

Appendix D: Chiller, Cooling Tower, Pump Nameplate, and Field Measurement Data

APPENDIX D

Table D-1. Chiller Nameplate and Field Measured Data

PLANT NO	PLANT BLDG NO	LOC CH NO	MEAS OA DB	MEAS OA WB	TRIP NOTES	PLANT CAP	MFG	MODEL NO	SERIAL NO	EQP YR	OPER SCHED	HAP LOAD	NOM ARI? CAP	COMP TYPE	REF TYPE	REF CHRG
			F	F		TONS					HR/YR	TONS	TONS			LBS
1	121	-	89	77		200.0	CARRIER	19DG5333CC	76-25-25213	76	4380	138		CENT, HERM	11	400
2	135	1/S-F	85	74	10	128.4	* TRANE	COMP MOD = 2-A518	N2C75S6882		4380	52		RECIP-1	12	300
	135	2/N-B	85	74			* WSTNGHS	PKB150	JG7218		4380	39		RECIP-1	22	
3	194	-	90	75		228.0	WSTNGHS	PE225	CR8600	73	4380	107		CENT, HERM	12	680
5	410	1/N-F	68	67		220.0	MCQUAY	PE050JAH10R1A31A2X	5PF0300800	84	4380	119	110	CENT, HERM	12	607
	410	2/S-B	68	67			MCQUAY	PE050JAH10R1A31A2X	5PF0301100	84	4380	119	110	CENT, HERM	12	607
6	2805	-	77	73		149.8	* AMER STD	COMP MTR MOD = LCF-1944	450-441	61	4380	116		CENT, HERM	113	400
7	5764	1	80	74		249.6	CARRIER	19C3D6-Q6-R6	60024904		4380	143		CENT, HERM	113	500
	5764	2			12						4380	58	80 ?	RECIP-2, PKG	? 22 ?	
8	5792	-	88	76		170.0	TRANE	PCV-1J-C2D3	L5B19100	75	4380	176	100	CENT, HERM, 2 STG	113	485
9	7050	1/E-F	69	66		420.0	WSTNGHS	PE063KAP26SC02H02X	GZ9000	81	8760	153	210	CENT, HERM	12	790
	7050	2/W-B	69	66			WSTNGHS	PE063KAP26SC02H02X	FZ9041	81	8760	153	210	CENT, HERM	12	790
10	7051	1A/S-B	76	74		170.0	YORK	YTA2B1B1-CFA	YHRM-200948	85	8760	158	150	CENT, OPEN	11	600
	7051	1B/N-F	76	74			YORK	YTA2B1B1-CFA	YHRM-200949	85	0	—	150	CENT, OPEN	11	600
13	14020	1	85	74		140.4	TRANE	CVHA-015C-HA-05CC1H1A-C1SH1A521	L77B21864	77	4380	154	150	CENT, HERM, 2 STG	113	415
14	14023	2	86	74		146.0	TRANE	CVHA-015C-HA-05CC1H1A-C1SH1A521	L77B21865	77	4380	166	150	CENT, HERM, 2 STG	113	415
15	21002	-	80	73		215.0	WSTNGHS	PE225	FP8615	71	4380	240	215	CENT, HERM	12	680
16	27004	-	79	72		465.0	WSTNGHS	PE460	JQ8575	72	4380	486	465	CENT, HERM	12	1300
17	28000	1/N-F	93	75		220.0	WSTNGHS	PE048JAE13RBA3AA2X	HZ9010	81	4380	119	110	CENT, HERM	12	390
	28000	2/S-B	93	75			WSTNGHS	PE048JAE13RBA3AA2X	HZ9004	81	4380	119	110	CENT, HERM	12	390
18	29005	2/S-L	68	66		948.0	TRANE	PCV-4F-C1D1	L4H18209	74	4380	452	400	CENT, HERM, 2 STG	11	880
	29005	1/N-R	68	66			TRANE	PCV-4F-C2D2	L4H18208	74	4380	384	400	CENT, HERM, 2 STG	11	880
19	31008	-	90	77	7	460.0	YORK	YSEBEAS4-CPA	YKYM773894	91	4380	458	500	SCREW	22	1350
20	34008	-	80	73		460.0	YORK	YSEBEAS4-CPA	YKYM773893	91	4380	485	500	SCREW	22	1350
21	36000	1/S-B	74	71	5	1277.0	YORK	YTH3J3E2-CRE	MRP439134	90	8760	362	500	CENT, OPEN	11	1400
	36000	2/M-M	74	71			YORK	YTH3J3E2-CRD	NA	89	8760	362		CENT, OPEN	11	1400
	36000	3/N-F	74	71			YORK	HTH4E2-EACS	KM-169129	80	8760	431	500	CENT, HERM	11	1150
22	36006	-	80	70		275.0	YORK	YTC3C3C2-CKD	YEYM-226389	88	4380	259	250 ?	CENT, OPEN	11	900
23	36009	-	85	78		95.5	CARRIER	30GA105400AA	M595118		4380	110	105	RECIP-4, PKG	22	360
	36014	2/S-B					TRANE	ABSC-01A4WG4B1F1EBD1	L79F03704	79	0	NI	101	ABSORP, 1 STG	LB-1	
24	36014	3/N-F	90	73	9	96.2	TRANE	CGHA-1001EA51CH5C4C361BE	L79G03695	79	8760	96	100	RECIP-1:4, HT REC	22	175
25	39015	1/S-R	77	71		1215.0	TRANE	CV-6C-G4-H4	L6G21256	76	4380	509	600	CENT, HERM, 2 STG	11	1250
	39015	2/N-L	77	71			TRANE	CV-6C-G6-H5	L6E21091	76	4380	471	600	CENT, HERM, 2 STG	11	1250
26	39043	1/W-R	65	64		1120.0	TRANE	CVHA-055C-HA-13NJ1AYA-J2SAZA511	L77D00867	77	4380	542	559	CENT, HERM, 2 STG	11	1100
	39043	2/E-L	65	64			TRANE	CVHB-061C-HA-13MK1AYA-K1SAZA511	L77D00868	77	4380	542	612	CENT, HERM, 2 STG	11	1250
27	41003	-	90	77		227.5	WSTNGHS	PE225	FP8610	71	4380	232	228	CENT, HERM	12	670
28	42000	-	90	75		209.0	YORK	HT-230	XO-221605	70	4380	189	230	CENT, HERM	11	650
29	50001	-	84	75		129.2	CARRIER	30-HS-160-D-600	P-271404		8760	129	160	RECIP-4, SPLIT	22	192
30	50004	1/M-M	84	74		375.0	YORK	HTA5A4-AAB	EM-057149-8609	75	8760	102	150	CENT, HERM	11	300
	50004	2/E-B	84	74			YORK	HTA5A4-AAB	EM-057150-8610	75	8760	102	150	CENT, HERM	11	300
	50004	3/W-F	84	74			YORK	OTA5A3-ODCTC	NM-053469	83	8760	102	120	CENT, OPEN	11	400
31	87018	2/N-L	69	68		948.0	TRANE	PCV-4D-C1D1	L4B17296	74	4380	487	400	CENT, HERM, 2 STG	11	880
	87018	1/S-R	69	68			TRANE	PCV-4D-C2D2	L4B17297	74	4380	415	400	CENT, HERM, 2 STG	11	880
32	91001	-	79	73		121.8	CARRIER	30GB125650	W595305	85	4380	123	125	RECIP-5, PKG	22	290

APPENDIX D

Table D-1. Chiller Nameplate and Field Measured Data

PLANT NO	BLDG NO	EVAP FLOW CONFIG	COND TYPE	EXIST vs 88/89	EVAP DSGN SRT F	EVAP DSGN EWT F	EVAP DSGN LWT F	EVAP DSGN FLOW GPM	EVAP DSGN CALC CAP TONS	EVAP DSGN SPEC CAP TONS	EVAP DSGN ••••••••• FUTURE CAP TONS	EVAP DSGN PASS	EVAP DSGN FOUL FACT	EVAP DSGN WPD FT	COND DSGN SRT F	COND DSGN EWT F	COND DSGN LWT F	COND DSGN FLOW GPM
1	121	SGL	WAT	SAME	35.1	56.9	45.0	389	192.9	200.0	138	2		12.1	104.4	85.0	94.7	600
2	135	SGL	WAT	SAME		53.0	45.0	230	76.7	73.5	91					85.0	95.0 ?	215
	135	SGL	WAT	NI					—	54.9 E	0							
3	194	SGL	WAT	SAME	36.0	52.5	44.0	646	228.8	228.0	107	2	0.00050	8.8	105.0	85.0	95.0	677
5	410	PAR	WAT	SAME	39.8	56.0	44.0	220	110.0	110.0	119	3	0.00050	9.9	101.0	85.0	94.7	330
	410	PAR	WAT	SAME	39.8	56.0	44.0	220	110.0	110.0	119	3	0.00050	9.9	101.0	85.0	94.7	330
6	2805	SGL	WAT	SAME			42.0	358 G	—	149.8	116							
7	5764	PAR ?	WAT	SAME		55.0	45.0	428	178.3	178.0	201							535
	5764	PAR ?	AIR ?	NI		55.0	45.0	172	71.7	71.6	0		0.00050	20.0 M		—	—	—
8	5792	SGL	WAT	SAME		52.9	44.0	458	169.8	170.0	SPEC	2RH	0.00050	17.0		85.0	93.4	580
9	7050	PAR	WAT	SAME X	34.7	56.0	46.0	497	207.1	210.0	(1)	2	0.00050	15.9	108.0	85.0	95.2	621
	7050	PAR	WAT	SAME X	34.7	56.0	46.0	497	207.1	210.0	(1)	2	0.00050	15.9	108.0	85.0	95.2	621
10	7051	SER/ACT	WAT	SAME X		54.0	44.0	408	170.0	170.0	(1)	2	0.00050	17.9		85.0	95.0	500
	7051	SER/RED	WAT	SAME X		54.0	44.0	408	170.0	170.0	(1)	2	0.00050	17.9		85.0	95.0	500
13	14020	SGL	WAT	SAME		55.4	44.0	296	140.6	140.4	154	2LH	0.00050	14.0		85.4	95.0	421
14	14023	SGL	WAT	SAME		55.6	44.0	302	146.0	146.0	166	2LH	0.00050	14.0		85.4	95.0	438
15	21002	SGL	WAT	SAME	35.1	54.0	43.0	474	217.3	215.0	240	2	0.00050	6.8	104.1	85.0	94.7	655
16	27004	SGL	WAT	SAME	33.2	53.4	43.0	1070	463.7	465.0	SPEC	2	0.00050	8.0	105.5	85.0	95.2	1340
17	28000	PAR	WAT	SAME X	39.0	56.0	44.0	220	110.0	110.0	119	3	0.00050	13.5	104.0	85.0	94.9	330
	28000	PAR	WAT	SAME X	39.0	56.0	44.0	220	110.0	110.0	119	3	0.00050	13.5	104.0	85.0	94.9	330
18	29005	SER/SGL	WAT	SAME		58.0	49.4	1422	509.6	512.0	(6)	1	0.00050	5.0		85.0	95.0	1422
	29005	SER/SGL	WAT	SAME		49.4	42.0	1422	438.5	436.0	(6)	1	0.00050	5.0		85.0	95.0	1422
19	31008	SGL	WAT	DIF		58.0	42.0	690	460.0	460.0	SPEC	3	0.00025	29.0		85.0	94.4	1380
20	34008	SGL	WAT	DIF		58.0	42.0	690	460.0	460.0	SPEC	3	0.00025	29.0		85.0	94.4	1380
21	36000	PAR	WAT	DIF		58.4	42.0	587	401.1	400.0	(7)	3	0.00025	16.2		85.0	94.4	1200
	36000	PAR	WAT	SAME		58.0	42.0	587	391.3	400.0	(7)	3	0.00025	16.2		85.0 ?	94.4 ?	1200
	36000	PAR	WAT	SAME		58.0	42.0	716	477.3	477.0	(7)	3	0.00050	29.4		85.0	95.0	1431
22	36006	SGL	WAT	SAME		50.5	44.0	1009	273.3	275.0	SPEC	2	0.00050	18.2		85.0	95.0	825
23	36009	SGL	AIR	SAME		52.8	44.0	260	95.3	95.5	110			15.0 S		—	—	—
	36014	SER/SGL	WAT	NI		53.3	49.8	328	47.8	48.0	0	4LH	0.00050	15.0		85.0	104.3	64
24	36014	SER/SGL	WAT	SIM		49.8	44.0	328	79.3	96.2	SPEC		0.00050	26.0		85.0	95.0	204
25	39015	SER/SGL	WAT	SAME		58.0	49.5	1695	600.3	631.0	509	1	0.00050	4.0		85.0	95.2 ?	1695
	39015	SER/SGL	WAT	SAME		49.5	42.0	1695	529.7	584.0	471	1	0.00050	4.0		85.0	94.0 ?	1695
26	39043	SER/SGL	WAT	SAME		56.1	49.1	1906	555.9	560.0	SPEC	1	0.00050	6.5		85.0	94.8	1680
	39043	SER/SGL	WAT	SAME		49.1	42.0	1906	563.9	560.0	SPEC	1	0.00050	5.6		85.0	94.8	1680
27	41003	SGL	WAT	SAME	36.5	54.3	43.0	482	226.9	227.5	SPEC	3	0.00050	20.2	105.0	85.0	95.0	673
28	42000	SGL	WAT	SAME		52.0	42.0	502 G	209.2	209.0	(8)	2	0.00050	17.1		85.0	95.0	627
29	50001	SGL	AIR	SAME		53.6	44.0	323	129.2	129.2	(2)		0.00050	15.0 S		—	—	—
30	50004	PAR	WAT	SAME		59.0	45.0	215	125.4	125.0	(2)	2	0.00050	6.0		85.0	95.0	375
	50004	PAR	WAT	SAME		59.0	45.0	215	125.4	125.0	(2)	2	0.00050	6.0		85.0	95.0	375
	50004	PAR	WAT	SAME		59.4	45.0	208	124.8	125.0	(2)	2	0.00050	9.2		85.0	95.0	375
31	87018	SER/SGL	WAT	SAME		58.0	49.4	1422	509.6	512.0	SPEC	1	0.00050	5.0		85.0	95.0	1422
	87018	SER/SGL	WAT	SAME		49.4	42.0	1422	438.5	436.0	SPEC	1	0.00050	5.0		85.0	95.0	1422
32	91001	SGL	AIR	SAME		52.5	44.0	344	121.8	121.8	SPEC					—	—	—

APPENDIX D

Table D-1. Chiller Nameplate and Field Measured Data

PLANT NO	PLANT BLDG NO	COND DSGN CALC CAP TONS	COND DSGN PASS	COND DSGN FOUL FACT	COND DSGN WPD FT	COMP DSGN IMP DIA IN	COMP DSGN STARTER TYPE	COMP DSGN POT VOLT	COMP DSGN CUR FLA	COMP DSGN CUR LRA	COMP DSGN POW HP	COMP DSGN POW KW	COMP DSGN FL EFF KW/TON	EVAP PERF SRP		EVAP PERF SRT F	EVAP PERF EWT F	EVAP PERF LWT F
1	121	242.5	1		2.9			480	225	1179 D		171.0	0.855	-13.0	"HG	47.3	56.0	53.4
2	135	89.6						208	190		75	66.2	0.901 E	67.5	PSIG	41.5	49.0	47.5
	135	-----						208	142	550 D		49.4	0.900 E	83.0	PSIG	49.3	51.2	49.8
3	194	282.1	2	0.00050	16.8		CLOSED-TRANS STAR-DELTA	460	265	1515 D	250	199.0	0.873	41.0	PSIG	44.4	54.2	50.5
5	410	133.4	2	0.00050	7.3			460	110	488 D		79.0	0.718	36.0	PSIG	39.0	54.0	44.0
	410	133.4	2	0.00050	7.3			460	110	488 D		79.0	0.718	36.0	PSIG	39.0	56.0	46.0
6	2805	-----					STAR-DELTA	440	175			134.8	0.900 E	-24.0	"HG	42.6	50.9	49.3
7	5764	-----						460	218	D		160.2	0.900 E	-24.0	"HG	42.6	55.7	47.0
	5764	-----	---	-------	---			480	73			71.6	1.000 E					
8	5792	203.0	2RH	0.00050	20.0	26.5	CLOSED-TRANS STAR-DELTA	480	212	1275 D		157.0	0.924	-20.0	"HG	64.2	51.6	46.5
9	7050	263.9	2	0.00100	10.8		CLOSED-TRANS STAR-DELTA	480	257	458 Y	273	193.0	0.919	35.0	PSIG	37.8	51.6	44.7
	7050	263.9	2	0.00100	10.8		CLOSED-TRANS STAR-DELTA	480	257	458 Y	273	193.0	0.919	32.0	PSIG	34.4	51.6	46.6
10	7051	208.3	2	0.00050	17.7		CLOSED-TRANS STAR-DELTA	460	166	1059 D	154	121.0	0.712	OFF		OFF	OFF	OFF
	7051	208.3	2	0.00050	17.7		CLOSED-TRANS STAR-DELTA	460	166	1059 D	154	121.0	0.712	-14.0	"HG	44.6	52.0	47.5
13	14020	168.4	2LH	0.00050	17.5	26.0	CLOSED-TRANS STAR-DELTA	460	183	980 D		119.4	0.850	-26.0	"HG	26.7	55.2	47.8
14	14023	175.2	2LH	0.00050	17.5	26.0	CLOSED-TRANS STAR-DELTA	460	183	980 D		124.2	0.851	-25.0	"HG	35.3	51.6	45.1
15	21002	264.7	2	0.00050	18.2		OPEN-TRANS STAR-DELTA	480	252	1300 D	250	188.0	0.874	33.0	PSIG	35.6	53.7	43.5
16	27004	569.5	2	0.00050	19.2		OPEN-TRANS STAR-DELTA	480	521	2520 D	500	408.0	0.877	37.0	PSIG	40.1	60.0	47.0
17	28000	136.1	2	0.00050	12.6		CLOSED-TRANS STAR-DELTA	460	120	634 D	135	85.0	0.773	33.0	PSIG	35.6	57.7	50.6
	28000	136.1	2	0.00050	12.6		CLOSED-TRANS STAR-DELTA	460	120	634 D	135	85.0	0.773	35.0	PSIG	37.8	59.3	49.5
18	29005	592.5	2LH	0.00050	16.1	29.0	CLOSED-TRANS STAR-DELTA	480	512	3120 D		400.0	0.781	-14.0	"HG	44.6	51.6	47.0
	29005	592.5	2LH	0.00050	16.1	30.0	CLOSED-TRANS STAR-DELTA	480	512	3120 D		400.0	0.917	-15.0	"HG	41.6	48.0	46.0
19	31008	540.5	2	0.00025	19.7		SOLID STATE	460	439	3111	384	301.0	0.654	74.0	PSIG	43.6	53.3	44.4
20	34008	540.5	2	0.00025	19.7		SOLID STATE	460	439	3111	384	301.0	0.654	74.2	PSIG	43.7	50.4	44.7
21	36000	470.0	2	0.00025	17.5		SOLID STATE	460	340	3246	318	250.0	0.625	7.1	PSIA	40.4	49.5	41.2
	36000	470.0	2	0.00025	17.5		SOLID STATE	480	331	3246		244.0	0.610	7.1	PSIA	40.4	49.2	40.9
	36000	596.3	2	0.00050	23.4		CLOSED-TRANS STAR-DELTA	460	530	2371		376.0	0.788	OFF		OFF	OFF	OFF
22	36006	343.8	2	0.00050	18.2		SOLID STATE RED VOLT	460	264	1950 D	233	185.0	0.673	7.5	PSIA	42.8	49.7	45.0
23	36009	-----	---	-------	---			200	116			95.5	1.000 E				50.2	40.5
	36014	51.5	2RH	0.00050	6.2			480	8	46	5	NA	----					
24	36014	85.0		0.00050	9.0		PART-WINDING	460	140	760 D		87.6	0.911				55.0	52.7
25	39015	720.4	2LH	0.00050	13.0	27.0	CLOSED-TRANS STAR-DELTA	460	609	3560	585	458.0	0.726	-12.5	"HG	48.9	52.0	46.0
	39015	635.6	2RH	0.00050	13.0	28.5	CLOSED-TRANS STAR-DELTA	460	583	3560		458.0	0.784	OFF		OFF	OFF	OFF
26	39043	686.0	2RH	0.00100	20.0		CLOSED-TRANS STAR-DELTA	480	609	3470 D		453.0	0.809	-15.0	"HG	53.1	61.7	57.8
	39043	686.0	2RH	0.00100	12.1	30.0	CLOSED-TRANS STAR-DELTA	480	615	3560 D		452.0	0.807	OFF		OFF	OFF	OFF
27	41003	280.4	2	0.00050	19.3		OPEN-TRANS STAR-DELTA	480	266	1300 D	250	199.0	0.875	34.0	PSIG	36.7	51.8	45.0
28	42000	261.3	2	0.00100	18.2		OPEN-TRANS STAR-DELTA	208	589	2673		190.0	0.909	-13.5	"HG	46.2	48.9	47.3
29	50001	-----	---	-------	---			460	68	D	148	129.2	1.000 E	60.0	PSIG	33.8	50.0	47.7
30	50004	156.3	2	0.00050	16.0		OPEN-TRANS RED VOLT	480	148	653		111.0	0.888	-17.0	"HG	35.3	62.0	57.0
	50004	156.3	2	0.00050	16.0		OPEN-TRANS RED VOLT	480	148	653		111.0	0.888	OFF		OFF	OFF	OFF
	50004	156.3	2	0.00050	24.2		SOLID STATE	480	129	630	115	94.0	0.752	-14.0	"HG	44.6	60.0	54.0
31	87018	592.5	2LH	0.00050	16.1	29.0	CLOSED-TRANS STAR-DELTA	480	501	3120 D		400.0	0.781	-16.0	"HG	38.5	47.0	44.0
	87018	592.5	2LH	0.00050	16.1	30.0	CLOSED-TRANS STAR-DELTA	480	501	3120 D		400.0	0.917	OFF		OFF	OFF	OFF
32	91001	-----	---	-------	---			460	52	D		121.8	1.000 E	50.0	PSIG	26.0	51.3	45.5

APPENDIX D

Table D-1. Chiller Nameplate and Field Measured Data

PLANT NO	PLANT BLDG NO	EVAP PERF EWP PSIG	EVAP PERF LWP PSIG	EVAP PERF WPD FT	EVAP PERF FLOW GPM	EVAP PERF ACT LOAD TONS	COND PERF SRP		COND PERF SRT F	COND PERF EWT F	COND PERF LWT F	COND PERF EWP PSIG	COND PERF LWP PSIG	COND PERF WPD FT	COND PERF FLOW GPM	COND PERF LOAD TONS	COMP PERF LIMIT SETPT %	COMP PERF CUR 1 AMP	COMP PERF CUR 2 AMP	COMP PERF CUR 3 AMP	COMP PERF CUR 4 AMP	COMP PERF CUR 5 AMP	COMP PERF CUR 6 AMP
1	121	31.5	25.5	14		----	1.0	PSIG	78.0	78.0	79.8	11.0	7.0	9		----	85	74	78	80			
2	135	CAN'T	CAN'T	--		----			88.0	77.6	84.5	13.5	8.5	12		----		55	58	60			
	135	CAN'T	CAN'T	--	143	8.3	157.0	PSIG	85.5	79.7	83.4	20.0	CAN'T	--		----		72	72	72			
3	194	CAN'T	CAN'T	--	490	75.5	98.0	PSIG	89.0	83.0	85.6	28.0	19.5	20		----		110	110	110			
5	410	26.0	23.0	7	240	100.0	110.0	PSIG	96.1	81.2	86.6	26.0	24.0	5		----		44	44	44			
	410	26.0	20.0	14	262	109.2	95.0	PSIG	87.1		82.0	27.5	25.0	6	130	----		40	40	40			
6	2805	59.0	51.0	18		----	-14.0	"HG	85.5	75.5	77.8	21.0	5.5	36		----		40	40	40			
7	5764	CAN'T	CAN'T	--	482	174.7	-9.0	"HG	99.0	83.5	87.5	16.5	10.5	14		----		101	102	101			
	5764			--		----								--		----							
8	5792	23.5	19.0	10	457	97.1	-6.0	"HG	105.5	79.9	82.9	28.5	CAN'T	--		----	80	80	78	80			
9	7050	47.0	42.0	12	825	237.2	115.0	PSIG	98.9	81.0	86.0	19.5	11.0	20		----		100	100	100			
	7050	42.0	35.5	15	825	171.9	115.0	PSIG	98.9	81.0	85.0	17.0	12.0	12		----	80	97	97	97			
10	7051	31.0	24.0	16	825	----	OFF		OFF	OFF	OFF	OFF	OFF	--		----		OFF	OFF	OFF			
	7051	39.5	31.0	20	825	154.7	5.0	PSIG	90.1	76.2	82.2	14.5	6.5	18	430	107.5		90	95	95			
13	14020	63.5	55.0	20	355	109.5	-12.0	"HG	91.2	82.4	86.2	29.0	19.5	22	470	74.4		92	90	92			
14	14023	36.0	25.5	24	325	88.0	-10.0	"HG	96.5	81.5	86.8	24.0	10.5	31	465	102.7		98	93	105			
15	21002	44.5	39.5	12	745	316.6	108.0	PSIG	95.0	80.5	87.0	22.5	10.0	29	760	205.8		160	168	160			
16	27004	50.0	37.0	30		----	117.0	PSIG	100.0	81.0	86.0	27.0	5.0	51	1260	262.5		195	195	195			
17	28000	20.0	12.0	18	220	65.1	133.0	PSIG	108.4	81.6	87.1	15.0	14.0	2	345	79.1		95	100	100			
	28000	20.0	11.0	21	205	83.7	147.0	PSIG	115.2	81.9	92.3	24.0	22.5	3	230	99.7		131	120	130			
18	29005	88.0	83.0	12	1590	304.8	5.0	PSIG	90.1	73.8	77.7	22.5	12.0	24		----		105	105	105			
	29005	96.0	91.0	12	1590	132.5	3.0	PSIG	84.3	71.7	74.0	21.5	11.5	23		----		90	100	100			
19	31008			--	1220	452.4	174.3	PSIG	92.2	83.3	90.6			--	860	261.6		301	293	287			
20	34008	39.0	16.0	53	1045	248.2	154.9	PSIG	84.6	79.9	84.2	14.0	5.0	21		----		223	218	216			
21	36000	90.5	85.5	12		----	20.2	PSIA	91.4	81.5	89.5	22.5	18.5	9	1466	488.7		283	296	287			
	36000	102.0	84.0	42		----	21.2	PSIA	94.0	81.3	90.0	26.0	16.5	22	1466	531.4		290	300	295			
	36000	OFF	OFF	--		----	OFF		OFF	OFF	OFF	OFF	OFF	--	1748	----		OFF	OFF	OFF			
22	36006	86.5	80.0	15	905	177.2	20.4	PSIA	91.9	81.0	88.3	NOTE	NOTE	--	285	86.7		145	150	150			
23	36009	75.0	70.0	12		----				----	----	----	----	--	----	----		160	160	160	96	96	96
	36014			--		----								--		----							
24	36014	68.0	48.0	46	500	47.9				79.8	88.3	12.5	8.5	9	290	102.7		92	92	92			
25	39015	73.0	70.0	7	2410	602.5	3.5	PSIG	85.8	79.7	81.2	29.0	12.0	39		----		251	251	251			
	39015	66.0	62.0	9	2410	----	OFF		OFF	OFF	OFF	CAN'T	CAN'T	--		----	60	OFF	OFF	OFF			
26	39043	80.0	75.0	12	2180	354.3	2.0	PSIG	81.2	70.7	74.5			--		----		55	55	55			
	39043	76.0	72.0	9	2180	----	OFF		OFF	OFF	OFF	28.0	13.5	33		----		OFF	OFF	OFF			
27	41003	41.5	33.0	20	705	199.8	125.0	PSIG	104.3	85.5	92.8	19.0	8.5	24	710	216.0		180	180	180			
28	42000	56.0	45.5	24		----	4.0	PSIG	87.2	76.7	79.4	23.5	13.5	23	720	81.0	YES	195	200	195			
29	50001	17.5	CAN'T	--		----			97.0	----	----	----	----	--	----	----		40	41	42	60	61	61
30	50004	44.0	39.0	12		----	9.0	PSIG	100.3	81.0	85.1			--		----	70	86	86	86			
	50004	45.0	38.0	16	430	----	OFF		OFF	OFF	OFF			--		----		OFF	OFF	OFF			
	50004	46.5	40.5	14	382	95.5	9.0	PSIG	100.3	77.4	83.7	23.0	9.5	31		----		110	110	110			
31	87018	72.0	68.0	9	1620	202.5	4.0	PSIG	87.2			22.0	14.0	18		----	60	120	120	120			
	87018	80.0	76.0	9	1620	----	OFF		OFF	OFF	OFF	19.0	11.0	18		----		OFF	OFF	OFF			
32	91001	51.0	46.5	10		----	230.0	PSIG	111.1	----	----	----	----	--	----	----		110	110	110			

APPENDIX D

Table D-1. Chiller Nameplate and Field Measured Data

PLANT NO	BLDG NO	NOTES
1	121	SCHEM EVAP GPM = 362, PERF FLA = 226
2	135	BUILT-UP UNIT, SEVERE SPREAD IN AMP READINGS, i.e. 80/78/110, W/ 5 PSI DRIFT SUCT PRESS
	135	EEAP RPT DOES NOT LIST 2nd CHILLER
3	194	SO VOLT = 440, SO FLA = 290, SO LRA = 1450 D
5	410	
	410	
6	2805	USES GLYCOL TO 18F, REBUILT '79/80
7	5764	PROJECT LOCATION & SERIAL NO CONFLICT, APPROX 1700 LBS OF REFRIG CANS IN ROOM, CALC EVAP FLOW PRO-RATED
	5764	EEAP RPT LISTS 2nd CHILLER BUT DOES NOT INCLUDE DATA
8	5792	SO VOLT = 460, SO FLA = 218, SO LRA = 1218, 16 GPM CLG, CONTROLS ARE "DELICATE"
9	7050	SCHED TONS = 208.5, CALC EVAP FLOW SPLIT EQUALLY
	7050	SCHED TONS = 208.5, CALC EVAP FLOW SPLIT EQUALLY
10	7051	ACTIVE/REDUNDANT CONFIG ? OFF, PROBABLY DUE TO LOW LOAD
	7051	ACTIVE/REDUNDANT CONFIG ?
13	14020	SO VOLT = 480, SO FLA = 161.4, SO LRA = 1025
14	14023	SO VOLT = 480, SO FLA = 167.8, SO LRA = 1025
15	21002	SCHED COND GPM = 623, OIL LEAK
16	27004	SO LISTS 2 UNITS, SO FLA = 546
17	28000	
	28000	
18	29005	MODEL & SERIAL REVERSED W/ OTHER UNIT, SO & ORIG FLA = 562, 4 GPM CLG
	29005	MODEL & SERIAL REVERSED W/ OTHER UNIT, SO FLA = 362 & 562, ORIG FLA = 362, 4 GPM CLG, OVERHAULED '91
19	31008	SLIDE VALVE @ 53%, AMPS @ 68%, OP HRS = 4736
20	34008	
21	36000	SO VOLT = 480, AMPS @ 85%, CALC COND FLOW PRO-RATED ASSUMING FLOW THRU DEAD CHILLER (TYP THIS BLDG)
	36000	EXCESS PURGE, AMPS @ 87%, CODE-KIT ADDED '93, SEE AUSTIN FOR ORIGINAL NAMEPLATE
	36000	SPEC'D W/ HOT GAS BYPASS, CODE-KIT ADDED 'XX ? OFF BECAUSE FILLED W/ AIR
22	36006	EXCESS PURGE, PERF VOLT = 480, PERF FLA = 258, PERF LRA = 2035, AMPS @ 67%, 2nd PASS EWP/LWP = 14.0/5.0
23	36009	? CKTS, MEAS AMPS FOR COMP'S 1 & 2 AND COMP'S 3 & 4
	36014	HOT WATER SOURCE, SO EWT/LWT = 48.0/44.0, EEAP RPT DOES NOT LIST 2nd CHILLER
24	36014	RPT LISTS BASE BID BUT ALT BID INST'D, SCHED TONS = 79.0, EWP/LWP = 12.5/8.5 & 12.0/8.0 FOR 2 COND IN PAR
25	39015	SCHED TONS = 600, ORIG FLA = 648, 4 GPM CLG, HOWLS & RUMBLES
	39015	SCHED TONS = 530, ORIG FLA = 620 OR 648, 4 GPM CLG, OFF DUE TO ELECTRICAL PROBLEM
26	39043	ORIG VOLT = 460, ORIG FLA = 639, SO LRA = 3640
	39043	ORIG VOLT = 460, ORIG FLA = 648, SO LRA = 3730, OFF DUE TO LOW LOAD
27	41003	SCHED COND GPM = 658
28	42000	NO LOAD DUE TO REMODEL, USES GLYCOL TO ?F, GLYCOL NOT SPEC'D ON SO
29	50001	2 CKTS, MEAS AMPS W/ 2 COMP'S ON
30	50004	NAMEPLATE PAINTED OVER
	50004	SPEC'D W/ 2-UNIT SEQ KIT, OFF DUE TO ELECTRICAL PROBLEM
	50004	SPEC'D W/ 3-UNIT SEQ KIT
31	87018	ORIG MODEL = C2D2, SO & ORIG FLA = 562, 4 GPM CLG, MOTOR REPL'D '77, 100 LB R-11 ADDED
	87018	ORIG MODEL = C1D1, ORIG FLA = 562 ? 4 GPM CLG, OFF DUE TO UNKNOWN PROBLEM
32	91001	2 CKTS, MEAS AMPS W/ 3 COMP'S ON

APPENDIX D

Table D-2. Chiller Reference Data From EEAP Report

PLANT NO	PLANT BLDG NO	PLANT HAP CALC LOAD	PLANT CAP	DWG YR	EQP YR	OPER SCHED	HAP LOAD	EVAP FLOW TYPE	EVAP DSGN CAP	COMP DSGN POW	COMP DSGN FL EFF	EVAP PERF EWT	EVAP PERF LWT	EVAP PERF EWP	EVAP PERF LWP	EVAP PERF WPD	EVAP PERF FLOW	EVAP PERF ACT LOAD	COND PERF EWT	COND PERF LWT	COND PERF EWP	COND PERF LWP	COND PERF WPD	COND PERF FLOW	COND PERF LOAD	COMP PERF POW
		TONS	TONS			HR/YR	TONS		TONS	KW	KW/TON	F	F	PSIG	PSIG	FT	GPM	TONS	F	F	PSIG	PSIG	FT	GPM	TONS	KW
1	121	138	193.0	65	76	SEAS	138	VAR	193.0	174.7	0.905	51.10	47.50	18	NA	–	375	56.3	78.19	81.03	18	7	25	602	71.2	66.86
2	135	52	71.5	55	55	SEAS	52	CONST	71.5	64.4	0.900	44.32	40.59	NA	NA	–	167	26.0	85.27	93.36	NA	NA	–	153	51.6	37.89
	135			NI	NI	SEAS	NI	NI	NI	—	NI	NI	NI	NI	NI	–	NI	—	NI	NI	NI	NI	–	NI	—	NI
3	194	107	228.0	72	73	SEAS	107	CONST	228.0	199.0	0.873	45.96	41.97	NA	NA	–	369	61.3	85.88	90.89	NA	NA	–	485	101.2	85.10
5	410	238	220.0	83	84	SEAS	119	CONST	110.0	79.0	0.718	51.51	41.78	24	19	12	189	76.6	80.41	88.84	26	23	7	333	117.0	59.10
	410			83	84	SEAS	119	CONST	110.0	79.0	0.718	51.71	41.97	25	20	12	167	67.8	80.41	88.63	26	24	5	324	111.0	57.47
6	2805	116	151.0	57	61	SEAS	116	VAR	151.0	135.9	0.900	52.53	49.28	51	43	18	159	21.5	78.19	80.62	19	9	23	278	28.1	42.82
7	5764	143	178.0	NA	60	SEAS	143	CONST	178.0	156.5	0.879	52.12	42.76	NA	NA	–	324	126.4	88.51	97.40	22	10	28	438	162.2	121.50
	5764			NI	NI	SEAS	NI	CONST	NI	—	NI	NI	NI	NI	NI	–	NI	—	—	—	–	–	–	—	—	NI
8	5792	176	181.0	74	74	SEAS	176	VAR	181.0	156.9	0.867	51.71	46.71	24	13	25	288	60.0	81.82	86.78	30	20	23	404	83.5	64.60
9	7050	306	382.0	80	82	YEAR	153	CONST	191.0	168.1	0.880	46.58	42.27	52	46	14	512	91.9	87.09	91.51	22	12	23	674	124.1	130.30
	7050			80	82	YEAR	153	CONST	191.0	168.1	0.880	46.58	41.68	54	48	14	512	104.5	86.69	91.30	28	13	35	737	141.6	150.40
10	7051	158	300.0	80	85	YEAR	158	CONST	150.0	106.5	0.710	52.74	43.95	36	28	18	369	135.1	80.41	88.42	NA	NA	–	584	194.9	97.55
	7051			80	85	YEAR	—	CONST	150.0	106.5	0.710	51.92	43.45	NA	NA	–	312	110.1	77.58	85.14	NA	NA	–	512	161.3	84.00
13	14020	154	161.0	78	78	SEAS	154	VAR	161.0	143.5	0.891	49.86	44.93	65	60	12	243	49.9	77.08	82.57	30	15	35	340	77.8	53.00
14	14023	166	161.0	78	78	SEAS	166	VAR	161.0	143.5	0.891	53.97	48.09	42	32	23	262	64.2	80.00	88.84	23	9	32	241	88.8	66.36
15	21002	240	215.0	70	71	SEAS	240	VAR	215.0	187.9	0.874	51.10	44.93	51	47	9	497	127.8	80.20	88.63	NA	NA	–	503	176.7	142.40
16	27004	486	465.0	72	74	SEAS	486	VAR	465.0	407.8	0.877	51.10	46.51	34	22	28	873	167.0	83.24	91.71	14	4	23	779	274.9	178.20
17	28000	238	220.0	83	83	SEAS	119	CONST	110.0	85.0	0.773	53.77	46.71	22	13	21	214	63.0	84.05	92.53	23	17	14	252	89.0	51.12
	28000			83	83	SEAS	119	CONST	110.0	85.0	0.773	53.97	46.12	22	12	23	187	61.2	84.26	92.74	23	NA	–	252	89.0	49.51
18	29005	836	937.0	75	75	SEAS	452	VAR	500.0	360.0	0.720	63.20	58.23	83	78	12	810	167.7	80.61	88.84	28	11	39	763	261.6	149.90
	29005			75	75	SEAS	384	VAR	437.0	362.7	0.830	58.07	50.36	91	87	9	1000	321.3	74.05	82.05	20	13	16	1500	500.0	322.00
19	31008	458	432.0	70	72	SEAS	458	VAR	432.0	366.8	0.849	51.51	44.34	50	46	9	904	270.1	79.19	86.37	NA	NA	–	1279	382.6	252.60
20	34008	485	465.0	72	74	SEAS	485	VAR	465.0	407.8	0.877	52.53	49.28	38	32	14	530	71.8	86.69	90.89	18	5	30	795	139.1	132.10
21	36000	1155	1252.0	84	63	YEAR	362	VAR	377.0	289.9	0.769	49.45	44.14	124	NA	–	857	189.6	84.66	89.66	NA	NA	–	1200	250.0	194.00
	36000			84	89	YEAR	362	VAR	400.0	244.0	0.610	50.68	41.38	NA	NA	–	1008	390.6	83.45	92.74	24	15	21	1145	443.2	240.20
	36000			86	84	YEAR	431	VAR	475.0	408.5	0.860	53.97	46.91	NA	115	–	701	206.2	83.45	87.40	32	NA	–	1746	287.4	202.60
22	36006	259	275.0	68	88	SEAS	259	CONST	275.0	184.3	0.670	47.09	43.06	NA	NA	–	545	91.5	81.32	87.40	NA	8	–	483	122.4	70.50
23	36009	110	102.0	75	75	SEAS	110	VAR	102.0	147.9	1.450	58.69	51.64	42	35	16	315	92.5	—	—	–	–	–	—	—	197.70
	36014			NI	NI	YEAR	NI	CONST	NI	—	NI	NI	NI	NI	NI	–	NI	—	NI	NI	NI	NI	–	NI	—	NI
24	36014	96	98.0	82	82	YEAR	96	CONST	98.0	85.3	0.870	56.23	50.07	56	40	37	242	62.1	87.91	98.40	12	4	18	191	83.5	76.11
25	39015	980	1228.0	75	75	SEAS	509	VAR	645.0	458.0	0.710	52.12	46.91	67	NA	–	1285	279.0	85.27	93.77	NA	NA	–	1131	400.6	263.41
	39015			75	75	SEAS	471	VAR	583.0	460.6	0.790	53.97	49.87	68	NA	–	1340	228.9	85.07	93.36	NA	NA	–	984	339.9	211.60
26	39043	1084	1192.0	78	78	SEAS	542	VAR	577.0	461.0	0.799	56.95	51.94	67	62	12	1444	301.4	80.00	88.63	30	NA	–	1180	424.3	276.30
	39043			78	78	SEAS	542	VAR	615.0	528.9	0.860	51.92	47.89	66	62	9	1444	242.5	80.00	84.73	35	20	35	1549	305.3	231.90
27	41003	232	228.0	71	72	SEAS	232	VAR	228.0	199.0	0.873	52.53	44.74	47	NA	–	400	129.8	81.82	89.45	NA	NA	–	539	171.4	131.40
28	42000	189	210.0	70	70	SEAS	189	CONST	210.0	189.0	0.900	48.84	46.91	46	35	25	494	39.7	77.18	80.62	20	8	28	404	57.9	57.66
29	50001	129	136.0	73	73	YEAR	129	VAR	136.0	174.1	1.280	47.19	44.74	27	NA	–	270	27.6	—	—	–	–	–	—	—	46.36
30	50004	306	365.0	82	NA	YEAR	102	CONST	120.0	99.6	0.830	50.38	44.93	42	37	12	290	65.9	79.60	84.11	22	11	25	488	91.7	58.00
	50004			82	NA	YEAR	102	CONST	120.0	99.6	0.830	62.38	51.05	45	41	9	167	78.8	80.81	89.25	22	10	28	279	98.1	63.69
	50004			82	82	YEAR	102	CONST	125.0	93.8	0.750	64.43	59.17	50	44	14	298	65.3	82.23	86.37	26	8	42	396	68.3	57.53
31	87018	902	886.0	75	72	SEAS	487	VAR	468.0	356.1	0.761	49.86	47.70	80	77	7	1215	109.4	82.03	86.58	21	14	16	1075	203.8	140.00
	87018			75	72	SEAS	415	VAR	418.0	356.1	0.852	52.33	47.50	96	93	7	1215	244.5	82.03	91.10	26	NA	–	857	323.9	251.20
32	91001	123	123.0	76	84	SEAS	123	VAR	123.0	173.4	1.410	56.64	48.68	74	NA	–	213	70.6	—	—	–	–	–	—	—	104.40

APPENDIX D

Table D-3. Cooling Tower Nameplate and Field Maesurement Data

PLANT NO	PLANT BLDG NO	MFG	MODEL NO	SERIAL NO	NOM CAP TONS	TOWER TYPE	FILL TYPE	FILL CONDITION	PAN CONDITION	FAN QTY	FAN TYPE	FAN CONFIG
1	121	MARLEY	NC	8807-4-194-79	250	OPEN				1	PROP	ID CROSS
2	135	MARLEY	AQUATOWER - VERT	4633-1288	75	OPEN		POOR		1	PROP	ID CROSS
	135	MARLEY	AQUATOWER - VERT	4740-150	40	OPEN				1	PROP	ID CROSS
3	194	PRTCHRD or GDFLLW				OPEN				1	PROP	ID CROSS
5	410	ALAMO				OPEN	MASONARY					ID COUNTER
6	2805	GOODFELLOW	PVMA175	78-1078		OPEN				1	PROP	ID CROSS
7	5764	BALTIMORE AIRCOIL	2415C	83-4634-D		OPEN	PVC	SOME CA		1	PROP	ID CROSS
8	5792	PRITCHARD-ECO	1-X708-6	PXA-8376-74		OPEN	WOOD SLAT	CA ON METAL, APD OK		1	PROP	ID CROSS
9	7050	BALTIMORE AIRCOIL	2415-C	81-2727-D		OPEN		CA & ALGAE	SOME ALGAE	1	PROP	ID CROSS
	7050	BALTIMORE AIRCOIL	2415-C	81-2726-D		OPEN		CA	SOME ALGAE	1	PROP	ID CROSS
10	7051	BALTIMORE AIRCOIL	3547	85-6716-D		OPEN		OK	OK	1	PROP	ID CROSS
	7051	BALTIMORE AIRCOIL	3547	85-6717-D		OPEN				1	PROP	ID CROSS
13	14020	BALTIMORE AIRCOIL	FXT-173C	89400991		OPEN			LOTS ALGAE	2	PROP	FD CROSS
14	14023	BALTIMORE AIRCOIL	FXT-173C	89400344		OPEN			LOTS ALGAE	2	PROP	FD CROSS
15	21002	MARLEY	NCII	8908-4-787-85	300	OPEN	PVC	SOME CA & ALGAE	SOME ALGAE	1	PROP	ID CROSS
16	27004	HAVENS	M-48-500	CO-722332		OPEN		SOME CA	OK	1	PROP	ID CROSS
17	28000	ALAMO				OPEN	MASONARY		ALGAE ON BOT			ID COUNTER
18	29005	PRITCHARD-ECO	1-Y1516-7 TOWER B	PYA-7723-73		OPEN	PVC	SOME CA	ALGAE	1	PROP	ID CROSS
19	31008	MARLEY	NC	8816-4-1216-83	600	OPEN	PVC	SOME CA		1	PROP	ID CROSS
20	34008	HAVENS	M-48-500	CQ-722332		OPEN	PVC	LOTS CA & ALGAE		1	PROP	ID CROSS
21	36000	MARLEY	DOUBLEFLOW [373 ?]	4678-82	NA	OPEN				2	PROP	ID CROSS
	36000	MARLEY	DOUBLEFLOW 365-102	4-1569-80	440	OPEN		QUITE FOULED		2	PROP	ID CROSS
22	36006	MARLEY	NC	8808-4-821-78	300	OPEN		LOTS CA ON LEAD EDGES		1	PROP	ID CROSS
23	36009	CARRIER	NA (INTEGRAL)	NA (INTEGRAL)		COND	NA	NA	NA	2	PROP	ID CROSS
24	36014	MARLEY	AQUATOWER - VERT	603944AX321	160	OPEN		GOOD		1	PROP	ID CROSS
25	39015	EVAPCO	LSTA-10-364	893829		OPEN			SEAMS LEAK	9	CENT	FD COUNTER
26	39043	SITE-ERECTED	TWO-CELL			OPEN	FIBERGLASS	OK	OK	2	PROP	ID COUNTER
27	41003	MARLEY	NCII	8908-4-788-85	300	OPEN	PVC	SOME CA & ALGAE, APD OK	ALGAE	1	PROP	ID CROSS
28	42000	BALTIMORE AIRCOIL	2417C	83-4635-D		OPEN	PVC	SOME CA, NOT BAD	ALGAE	1	PROP	ID CROSS
29	50001	CARRIER	09DE084600	U396035		COND	NA	NA	NA	6	PROP	ID CROSS
	50001	CARRIER	09DE084600	U396034		COND	NA	NA	NA	6	PROP	ID CROSS
30	50004	TRI-THERMAL	MT-70147	20-67-91		OPEN				1	PROP	ID CROSS
	50004	TRI-THERMAL	MT-70147	20-67-91-1		OPEN				1	PROP	ID CROSS
	50004	BALTIMORE AIRCOIL	2413C	82-4040-D		OPEN	PVC	SOME CA, NOT BAD		1	PROP	ID CROSS
31	87018	PRITCHARD-ECO	1-Y1516-7 TOWER A	PYA-7723-73		OPEN	PVC	SOME CA	LOTS ALGAE	1	PROP	ID CROSS
32	91001	CARRIER	NA (INTEGRAL)	NA (INTEGRAL)		COND	NA	NA	NA	10	PROP	ID CROSS

APPENDIX D

Table D-3. Cooling Tower Nameplate and Field Maesurement Data

PLANT NO	PLANT BLDG NO	CTRL TYPE	CTRL STATUS	PERF MEAS EWT F	PERF MEAS LWT F	PERF MEAS EAT DB F	PERF MEAS EAT WB F	PERF MEAS LAT DB F	PERF MEAS LAT WB F	PERF MEAS APD IN WG	MOTOR MFG	MODEL [CAT, PRT] NO	SERIAL NO	FRAME	QTY	DSGN POW HP
1	121	NOT BYPASS								0.55	GEN ELECT	5K215BC205A		215T	1	10
2	135	BYPASS		87.6	82.0	84.0	73.0	78.1		0.20	BALDOR	M7042T	36N04-1868		1	3
	135	BYPASS	DISABLED	87.2	82.0	84.0	73.0	78.6		0.70	LINCOLN			145T	1	2
3	194	BYPASS	DISABLED	86.6	84.2	90.0	75.0	85.2		0.50						
5	410															
6	2805	NOT BYPASS				77.0	72.0	76.1		0.55						
7	5764	NOT BYPASS		86.2	83.7	84.0	76.0	85.0	84.5	0.30					1	
8	5792			83.4	80.4	88.0	76.0	83.0	79.0	0.50				256T	1	20
9	7050	BYPASS	STUCK	86.0	81.0			76.0	75.0	0.70					1	
	7050	BYPASS	STUCK					80.0	79.0	0.55					1	
10	7051	BYPASS	DISABLED											213T	1	7.5
	7051	BYPASS	DISABLED	83.0	77.2	79.0	74.0	82.0	82.0	0.40					1	
13	14020			83.3	81.6	89.0	77.0	84.0	83.0	0.45					1	
14	14023			86.5	80.5	90.0	75.0	82.0	81.0	0.60					1	
15	21002	NOT BYPASS		86.4	79.5	80.0	73.0	84.0		0.95	RELIANCE			254T	1	15
16	27004	NOT BYPASS		86.0	81.0	80.0	74.0			0.90					1	
17	28000															
18	29005	BYPASS	DISABLED			68.0	66.0			0.90	DELCO	2V8100–	77513-77613LR1RV	364T	1	60
19	31008	NOT BYPASS		90.7	83.2	90.0	77.0			0.60						40
20	34008	NOT BYPASS				79.0	72.0	84.0	83.0	0.60					1	25
21	36000	BYPASS (2)	SEEMS OK							0.35	VANGUOUT & SIEMENS			254T	2	15
	36000	BYPASS (2)												254T	2	15
22	36006	BYPASS	DISABLED	87.0	81.1	80.0	70.0	83.0	82.0	0.80	ALLIS CHALMERS	627	51-305-629	254T	1	15
23	36009	NA	NA	NA	NA	85.0	78.0			0.38					2	7.5
24	36014	BYPASS	DISABLED	89.0	76.0	92.0	75.0	82.0	72.0	0.40				213T	1	7.5
25	39015	BYPASS	DISABLED			77.0	70.0			0.81					3&3	30 & 15
26	39043	BYPASS	SEEMS OK								RELIANCE		1M0478396-G2-VC	326T	1	40 & 10
27	41003	NOT BYPASS		91.0	84.8	90.0	77.0	84.0		0.90	RELIANCE			254T	1	15
28	42000	BYPASS	INOPER ?	82.1	79.3	90.0	75.0	78.6	77.0	0.70					1	
29	50001	NA	NA	NA	NA	83.0	109			0.40					4&2	.75 & .71
	50001	NA	NA	NA	NA										4&2	.75 & .71
30	50004	BYPASS	INOPER ?			83.0	72.0	82.0	81.0	0.25	MARATHON			215T	1	10
	50004	BYPASS								0.40					1	10
	50004	BYPASS													1	
31	87018	BYPASS	DISABLED			65.0	64.0				CENTURY	6-321757-03		364T	1	60
32	91001	NA	NA	NA	NA	80.0	106			0.70					10	1.75

APPENDIX D

Table D-3. Cooling Tower Nameplate and Field Maesurement Data

PLANT NO	PLANT BLDG NO	DSGN SPD RPM	MULTI SPD	DSGN POT VOLT	DSGN PH	DSGN CUR FLA	DSGN SERV FACT %	DSGN EFF %	PERF POT VOLT	PERF CUR 1 AMP	PERF CUR 2 AMP	PERF CUR 3 AMP	PRELIMINARY RECOMMEND	NOTES
1	121	1740		230/460	3		1.15						REPLACE	SPLASH PLATES DISLODGED & CORRODED, FAN CYCLING
2	135	1725		230/460	3	8.6/4.3	1.00							FAN DISCHARGING WATER, CASING RUSTED W/ HOLES
	135	1720		208	3	7.1								FAN CYCLING
3	194													EXCESSIVE VIBRATION
5	410		2						470	16.0	17.0	16.5	RETAIN	INACCESSIBLE W/O LADDER
6	2805													WATER FLOW SEEMS EXCESSIVE, OVERFLOW PLUGGED
7	5764			460	3									SPLASH PLATES CORRODED
8	5792	1750		230/460	3		1.15						REPLACE	
9	7050								470	8.4	8.9	9.3	REPLACE	
	7050								470	9.4	9.5	9.8	REPLACE	
10	7051	1730		230/460	3		1.00	86.5		OFF	OFF	OFF		ALSO SERVES HEAT PUMP LOOP, DRAINED DOWN
	7051													ALSO SERVES HEAT PUMP LOOP
13	14020												REPLACE	LOTS LOOSE NOZZLES ATOP UNIT (PROBLEM ?)
14	14023												REPLACE	LOTS LOOSE NOZZLES ATOP UNIT (PROBLEM ?)
15	21002	1760		230/460	3	40.0/20.0	1.15							
16	27004													FAN APPEARS OUT OF BALANCE
17	28000		2										RETAIN	INACCESSIBLE W/O LADDER, RAN DRY DURING TRIP
18	29005	1770		230/460	3		1.00			OFF	OFF	OFF	REPLACE	WATER DIST SUSPECT, SPLASHING TO GROUND BOTH ENDS
19	31008													TOP INACCESSIBLE
20	34008	1750		230/460	3									
21	36000	1770		230/460	3									
	36000	1745		230/460	3									APPEARS FULL BYPASS W/ BOTH FANS ON
22	36006	1750		230/460	3	38.0/19.0	1.15							WATER GREEN & FOAMY
23	36009			200	3	25.4&23.8								LEAD SECTION DIRTY
24	36014	1745		230/460	3	19.6/9.8	1.15							
25	39015			230/460	3									PONY BELTS REMOVED, FLOW TO 1 OF 3 CELLS CLOSED
26	39043	1755/ 875	2	460	3	48.0&15.0							RETAIN	
27	41003	1760		230/460		40.0/20.0								EXCESSIVE VIBRATION (FAN OUT OF BALANCE ?)
28	42000													
29	50001			460	1	3.3								RECEIVES RECIRC FROM ADJACENT PROCESS CONDENSERS
	50001			460	1	3.3								RECEIVES RECIRC FROM ADJACENT PROCESS CONDENSERS
30	50004	1740		230/460	3	26.0/13.0	1.15	87.5						
	50004	1740		230/460	3									
	50004													INACCESSIBLE TO OBTAIN DATA
31	87018	1770		230/460	3	140.0/70.0	1.00						REPLACE	WATER DIST SUSPECT, SPLASHING TO GROUND ONE END
32	91001			460	3	3.0								LEAD SECTION DIRTY, SOME BENT FINS

APPENDIX D

Table D-4. Chilled Water Pump Nameplate and Field Measurement Data

PLANT NO	PLANT BLDG NO	MFG	MODEL [CAT, SPEC] NO	SERIAL NO	OPER SCHED HR/YR	SIZE	ORIENT	CPLNG	SUCT	FLOW CONFIG SUCT	FLOW CONFIG DISCH	EQP YR	DSGN FLOW GPM	DSGN HEAD FT	PERF MEAS FLOW GPM	PERF CALC HEAD FT	PERF EFF %	PERF POW BHP
1	121	PEERLESS	PB	315701	4380	3 x 4 x 10	HOR	SPLIT	END	-	-	66	389	78	375	CAN'T	CAN'T	CAN'T
2	135	BELL & GOSSETT	1531 : 318TB	1154565	4380	2.5 x 3 x ?	HOR	CLOSE	END	SYS-DED	CH-1/S	NA	215	53	167	CAN'T	CAN'T	CAN'T
	135	PACO	15955 : 1J-292-682	B2HY28483	4380	1.5 x 2 x 9.5	HOR	CLOSE	END	SYS-DED	CH-2/N	NI	NI	NI	NI	NI	NI	NI
3	194	PACO	30125 : 3CC-LH62	DID22650	4380	3 x 4 x 12	HOR	SPLIT	END	-	-	73	646	NA	369	126	72	16.5
5	410	AURORA	411-SF	84-02968-2	4380	2.5 x 3 x 10B	HOR	SPLIT	DBL	CH-1/N	SYS-HDR	84	220	62	189	64	68	4.5
	410	AURORA	411-SF	84-02968-1	4380	2.5 x 3 x 10B	HOR	SPLIT	DBL	CH-2/S	SYS-HDR	84	220	62	167	65	65	4.3
6	2805	BELL & GOSSETT	1510 : Q-51191-4BB-91/2-BF-FM		4380	4 x ? x ?	HOR	SPLIT	END	-	-	61	162	55	159	97	47	8.2
7	5764	BELL & GOSSETT	1531 : 4BC-87/8-BF	1268815-A58	4380	4 x 5 x ?	HOR	CLOSE	END	-	-	85	600	65	454	CAN'T	CAN'T	CAN'T
8	5792	PACO	11-30121-046201-1852? (?=D)	GKN11252	4380	3 x 4 x 12	HOR	SPLIT	END	-	-	74	457	85	288	105	67	11.5
9	7050	WEINMAN	4G25-2	735665-1	8760	4 x 5 x 7	HOR	CLOSE	END	SYS-HDR	CH-HDR	82	372	66	512	124	82	19.4
	7050	WEINMAN	4G25-2	735665-2	8760	4 x 5 x 7	HOR	CLOSE	END	SYS-HDR	CH-HDR	82	372	66	512	124	82	19.4
10	7051	TACO	BB5010-8.55-C5B-2HL1	B7873Y	8760	5 x 10	HOR	SPLIT	END	SYS-HDR	CH-HDR	85	408	57	369	67	70	8.9
	7051	TACO	BB5010-8.55-C5B-2HL1	B7873Y	0	5 x 10	HOR	SPLIT	END	SYS-HDR	CH-HDR	85	408	57	312	67	65	8.1
13	14020	PACO	11-30951-133201-1782	BNS08123	4380		HOR	SPLIT	END	-	-	78	296	85	243	89	72	7.6
14	14023	PACO	11-30951-133201-1782	BNS08124	4380		HOR	SPLIT	END	-	-	78	302	85	262	88	75	8.0
15	21002	DUNHAM-BUSH	B9TC-1	42614	4380	3	HOR	SPLIT	END	-	-	71	474	87	497	84	77	13.6
16	27004				4380		HOR	CLOSE	END	SYS-DED	CH-HDR	74	519	64	CAN'T	CAN'T	CAN'T	CAN'T
	27004	PACO	10-40705-130001-182	EKN15020-B	4380	4 x 5 x 7	HOR	CLOSE	END	SYS-DED	CH-HDR	74	551	70	CAN'T	CAN'T	CAN'T	CAN'T
17	28000	PACO	29-20951-720061-A02-1	GTMF00446-B	4380	2 x 2.5 x 9.5	HOR	SPLIT	DBL	CH-1/N	SYS-HDR	83	220	62	214	64	60	5.9
	28000	PACO	29-20951-720061-A02-1	GTMF00446-A	4380	2 x 2.5 x 9.5	HOR	SPLIT	DBL	CH-2/S	SYS-HDR	83	220	62	187	71	64	5.4
18	29005	AURORA	411-BF	73-7739-1	4380	4 x 5 x 15	HOR	SPLIT	DBL	SYS-HDR	CH-HDR	75	711	170	453	183	63	33.2
	29005	AURORA	411-BF	73-7739-2	4380	4 x 5 x 15	HOR	SPLIT	DBL	SYS-HDR	CH-HDR	75	711	170	453	183	63	33.2
19	31008	PACO	10-40127-1A0001-1872	91R81288MR04-A	4380	4 x 5 x 12	HOR	CLOSE	END	SYS-DED	CH-HDR	DIF	DIF	DIF	DIF	DIF	DIF	DIF
	31008	PACO	10-40127-1A0001-1872	91R81288MR04-B	4380	4 x 5 x 12	HOR	CLOSE	END	SYS-DED	CH-HDR	DIF	DIF	DIF	DIF	DIF	DIF	DIF
20	34008	TACO	CM4010 : B2F950636		4380	5 x 4 x 10	HOR	CLOSE	END	SYS-DED	CH-HDR	DIF	DIF	DIF	DIF	DIF	DIF	DIF
	34008	TACO	CM4010 : B2F950636		4380	5 x 4 x 10	HOR	CLOSE	END	SYS-DED	CH-HDR	DIF	DIF	DIF	DIF	DIF	DIF	DIF
21	36000	AERMTR, WNMN, MDLND	4L1-2	26720	8760	4 x 5 x 14A	HOR	SPLIT	DBL	SYS-HDR	CH-HDR	DIF	DIF	DIF	CAN'T	CAN'T	CAN'T	CAN'T
	36000	AERMTR, WNMN, MDLND	4L1 : 4L1-410-2SC20	C79869	8760	4 x 5 x 14A	HOR	SPLIT	DBL	SYS-HDR	CH-HDR	NA	545	195	CAN'T	CAN'T	CAN'T	CAN'T
	36000	AURORA	411-BF	89-04044-3	8760	4 x 5 x 15	HOR	SPLIT	DBL	SYS-HDR	CH-HDR	NI	NI	NI	NI	NI	NI	NI
	36000	WEINMAN	5L-1	731620-1	8760		HOR	SPLIT	DBL	SYS-HDR	CH-HDR	86	716	195	CAN'T	CAN'T	CAN'T	CAN'T
22	36006	AURORA	411-BF	89-08589-2	8760	8 x 8 x 11B	HOR	SPLIT	DBL	-	-	68	1010	25	545	32	67	6.6
23	36009	AURORA	341A-BF	75-7858	4380	2.5 x 3 x 9	HOR	CLOSE	END	-	-	75	260	67	315	61	73	6.7
24	36014	AURORA	341A-BF	91-04220-1	8760	2.5 x 3 x 7B	HOR	CLOSE	END	SYS-HDR	CH-2/S	82	DIF	DIF	242	155	67	14.2
25	39015	AURORA	411-BF	76-364-1	4380	4 x 5 x 15	HOR	SPLIT	DBL	SYS-HDR	CH-HDR	75	848	170	656	191	73	43.2
	39015	AURORA	411-BF	76-364-2	4380	4 x 5 x 15	HOR	SPLIT	DBL	SYS-HDR	CH-HDR	75	848	170	656	191	73	43.2
26	39043	AURORA	411-BF		4380	4 x 5 x 10B	HOR	SPLIT	DBL	SYS-HDR	CH-HDR	78	953	200	722	234	80	53.7
	39043	AURORA	411-BF	92-11829	4380	4 x 5 x 10B	HOR	SPLIT	DBL	SYS-HDR	CH-HDR	78	953	200	722	234	80	53.7
27	41003	DUNHAM-BUSH	B9TC-1	42612	4380	3	HOR	SPLIT	END	-	-	72	502	60	400	84	73	11.6
28	42000	DUNHAM-BUSH	B9C87-1	60462	4380	3	HOR	SPLIT	END	-	-	70	482	81	494	82	77	13.0
29	50001	WEINMAN	3GB-2A : 3G-301-1GK-4-2BA-87	734990	8760	3 x 4 x 7	HOR	SPLIT	END	-	-	73	325	77	270	82	75	7.3
30	50004	AURORA	411-BF	90-12217-2	8760	2.5 x 3 x 10B	HOR	SPLIT	DBL	SYS-HDR	CH-1/M	82	208	75	290	72	75	7.1
	50004	PACO	29-30957-120001	XE90E01830	8760		HOR	SPLIT	DBL	SYS-HDR	CH-2/E	82	208	75	167	88	67	5.8
	50004	AURORA	411-BF	90-12217-1	8760	2.5 x 3 x 10B	HOR	SPLIT	DBL	SYS-HDR	CH-3/W	82	208	75	298	71	74	7.3
31	87018	AURORA	411-BF	73-7738-1	4380	4 x 5 x 15	HOR	SPLIT	DBL	SYS-HDR	CH-HDR	72	711	170	608	177	72	37.7
	87018	AURORA	411-BF	73-7738-2	4380	4 x 5 x 15	HOR	SPLIT	DBL	SYS-HDR	CH-HDR	72	711	170	608	177	72	37.7
32	91001	BELL & GOSSETT			4380		HOR	CLOSE	END	-	-	76	344	60	213	CAN'T	CAN'T	CAN'T

APPENDIX D

Table D-4. Chilled Water Pump Nameplate and Field Measurement Data

PLANT NO	PLANT BLDG NO	DSGN FLOW	DSGN HEAD	DSGN SPD	DSGN IMP DIA		PERF MEAS EWP	PERF MEAS LWP	PERF MEAS HEAD	PERF CALC FLOW	MFG	MODEL [CAT, PRT] NO	SERIAL [CODE, ID, REF, SPEC] NO	FRAME	DSGN POW	DSGN SPD	DSGN POT	DSGN PH
		GPM	FT	RPM	IN		PSIG	PSIG	FT	GPM					HP	RPM	VOLT	
1	121						24.5	50.5	60	—	WSTNGHS	319B314G89X	6606	256U	10	1745	240/480	3
2	135			1750			17.0	45.0	65	—	MARATHON	NVL184TTDR7357ANL		184JM	5	1740	208-230/460	3
	135	143	65	1750			40.0	68.0	65	143	STERLING ELECT	W2556-2		215YZ	5	1800	208-220	3
3	194	640	100	1750			10.0	61.0	118	490	CENTURY	SC-324U-FCAEM1-9-302205-01	10F		25	1730	208-220/440	3
5	410	220	62	1750			18.0	44.0	60	240	MARATHON	NVN213TTDR7026GPL		213T	7.5	1750	208-230/460	3
	410	220	62	1750			19.0	44.0	58	262	MARATHON	NVN213TTDR7026GPL		213T	7.5	1750	208-230/460	3
6	2805	450	80	1750	9.500	MOD	CAN'T	CAN'T —		—	MARATHON	XH284UT4R26BAW	55787	284U	15	1735	208-220/440	3
7	5764	600	65	1750	8.875	MOD	4.5	31.5	62	675	U.S. ELECT		F-B045-00-045-K271R073	254JP	15	1765	200	3
8	5792	457	83	1750			14.5	50.5	83	457	U.S. ELECT		9403610-371BR21947	256T	20	1750	230/460	3
9	7050	497	125	3500			14.0	46.0	74	825	U.S. ELECT		R-6129-08-117-M	256JP	25	3520	230/460	3
	7050	497	125	3500			12.0	44.0	74	825	U.S. ELECT		R-6129-08-117-M	256JP	25	3520	230/460	3
10	7051	408	66	1750	8.550	MOD	10.0	38.0	65	430	BALDOR	M2513T	39B01X50	254T	15	1760	230/460	3
	7051	408	66	1750	8.550	MOD	10.0	38.5	66	395	BALDOR	M2513T	39B01X50	254T	15	1760	230/460	3
13	14020	296	85	1750			31.0	65.0	79	355	MAGNETEK	6-357722-01	BK5-06	S215T	10	1750	208-230/460	3
14	14023	302	85	1750			2.0	38.0	83	325	BALDOR	M3714T	F484	215T	10	1725	208-230/460	3
15	21002	474	87	1750	9.000	ACT	18.0	48.0	69	745	CENTURY	6-323411-01	2L	256T	20	1750	230/460	3
16	27004						6.0	45.0	90	—	U.S. ELECT		B085/T01S326R048F	215JM	15	3480	230/460	3
	27004	594	64	3500			10.0	42.0	74	435	GEN ELECT	5K215DN107		215TY	15	3520	230/460	3
17	28000	220	62	1750	9.100	ACT	10.0	36.5	61	220	MAGNETEK/CENTURY	9-391021-60	B?O5 (?=J)	213T	7.5	1740	230/460	3
	28000	220	62	1750	9.100	ACT	8.0	37.0	67	205	U.S. ELECT		F-9237-06-168	213T	7.5	1755	230/460	3
18	29005	711	170	1750			31.0	100.0	159	830	GOULD	6-321177-05		364TS	60	1770	230/460	3
	29005	711	170	1750			27.0	99.0	166	760	MARATHON	364TSTDS7026CB	BB-96583-74-14	364TS	60	1770	230/460	3
19	31008	700	90	1750	9.800	ACT	28.5	70.5	97	570	U.S. ELECT		E692AV06V119R163F	284JM	25	1760	230/460	3
	31008	700	90	1750	9.800	ACT	31.0	71.5	94	650	U.S. ELECT		E692AV06V119R163F	284JM	25	1760	230/460	3
20	34008	750	90	1760	9.700	ACT	10.5	54.5	102	435	U.S. ELECT			284JP	25	1760	230/460	3
	34008	750	90	1760	9.700	ACT	11.5	53.5	97	610	U.S. ELECT			284JP	25	1760	230/460	3
21	36000	545	195	1750			CAN'T	CAN'T —		—	LINCOLN		2265774	326T	50	1770	230/460	3
	36000	545	195	1750			55.0	CAN'T —		—	LINCOLN		2265776	326T	50	1770	230/460	3
	36000	716	195	1750			OFF	OFF —		—	GEN ELECT	5K364AL205D2	ZEG513227	364T	60	1780	230/460	3
	36000	716	195	1750			OFF	OFF —		—	LINCOLN		2277820	365TS	75	1775	230/460	3
22	36006	1015	25	1150			75.0	86.5	27	905	DAYTON	3N692	R100649C911	256T	10	1140	208-230/460	3
23	36009	260	67	1750			OFF	OFF —		—	U.S. ELECT		64-01251-265	213JM	7.5	1740	200	3
24	36014	328	148	3500			24.0	74.0	116	500	GEN ELECT	5K254?D121 (?=3)		254JM	20	3535	200-230/460	3
25	39015	848	174	1750			24.0	74.0	116	1220	GOULD	6-321177-05		364TS	60	1770	230/460	3
	39015	848	174	1750			22.0	75.0	122	1190	GOULD	6-321177-05		364TS	60	1770	230/460	3
26	39043	953	200	3500			5.0	82.0	178	1060	MARATHON	364TSTDS7001EDW	EN-ER4340	364TS	75	3550	460	3
	39043	953	200	3500			10.0	81.5	165	1120	GOULD	6-320786-05		364TS	75	3550	230/460	3
27	41003	506	76	1750	8.875	ACT	13.0	43.0	69	705	RELIANCE		P25G5078A	254T	15	1765	230/460	3
28	42000	482	81	1750			25.0	CAN'T —		—	GOULD/CENTURY	6-323409-02		254T	15	1750	230/460	3
29	50001	325	77	3500				CAN'T —		—	BALDOR	M3314T	380	215T	15	3450	208-230/460	3
30	50004	212	80	1750					0	—	MARATHON	NVC213TTDR7026GPW		213T	7.5	1750	208-230/460	3
	50004	212	80	1750	8.600	ACT	17.0	46.5	68	430	GOULD	6-330771-03	24	S213?	7.5	1750	230/460	3
	50004	212	80	1750			30.0	54.0	55	382	MARATHON	NVC213TTDR7026GPW		213T	7.5	1750	208-230/460	3
31	87018	711	170	1750			15.6	85.0	160	810	MARATHON	364TSTDS7026CB	AJ-96583-313-1	364TS	60	1775	230/460	3
	87018	711	170	1750			15.5	85.0	161	810	MARATHON	364TSTDS7026CB	AL-96853-425-9	364TS	60	1775	230/460	3
32	91001	344	60				33.0	54.5	50	—	U.S. ELECT		C548/R05R075R088F	213JM	7.5	1740	230/460	3

APPENDIX D

Table D-4. Chilled Water Pump Nameplate and Field Measurement Data

PLANT NO	PLANT BLDG NO	DSGN CUR	DSGN SERV FACT	DSGN EFF		DSGN POW FACT	PERF POT	PERF CUR 1	PERF CUR 2	PERF CUR 3	NOTES
		FLA	%	%		%	VOLT	AMP	AMP	AMP	
1	121		1.15								
2	135	13.6-13.2/6.6	1.15	85.5	NEMA	81.0	200	11.0	11.6	11.3	PUMP ID = 177716-B48
	135	14.8-14.0									
3	194	65.0-61.0/30.5	1.15								
5	410	21.6/10.8	1.15	84.0	NOM	76.6					
	410	21.6/10.8	1.15	84.0	NOM	76.6					
6	2805	38.0/19.0	1.15				475	10.9	10.9	11.1	PUMP ID = 665030
7	5764	45.0	1.25	89.5	NEMA						SERVES 2nd AIR-COOLED CHILLER IN PARALLEL ?
8	5792	54.0/27.0	1.15								HVAC PIPING IS CHANGEOVER W/ HTG & CLG PUMPS
9	7050	62.4/31.2	1.15	86.5	NEMA						
	7050	62.4/31.2	1.15	86.5	NEMA			13.8	13.8	12.5	
10	7051		1.15	86.0	FL	81.0					
	7051		1.15	86.0	FL	81.0					
13	14020	26.4-25.0/12.5	1.15	85.6		87.5					MOTOR CAT = R309
14	14023	28.0-26.0/13.0	1.00	87.0	FL	82.0					MOTOR SPEC = 37A01Z50
15	21002	50.0/25.0	1.15								
16	27004	36.6/18.3	1.25								
	27004	38.4/19.2	1.15								
17	28000		1.15	88.5	NEMA	87.0					MOTOR CAT = T345
	28000		1.15	85.5	NEMA						
18	29005	140.0/70.0	1.15								
	29005	148.0/74.0	1.15	91.0	FACT	80.5		51.0	51.0	51.0	
19	31008		1.15	89.2	FACT	83.0					DSGN EFF 89.5 NEMA (MTR)
	31008		1.15	89.2	FACT	83.0					DSGN EFF 89.5 NEMA (MTR)
20	34008	64.8/32.4	1.15	89.5	NEMA						
	34008	64.8/32.4	1.15	89.5	NEMA						
21	36000	125.0/62.5	1.15	E	INDX						
	36000	125.0/62.5	1.15	E	INDX						REPLACED ONE GAUGE COCK
	36000	145.6/72.8	1.15	92.4	NEMA			OFF	OFF	OFF	
	36000	192.0/96.0	1.15	E	INDX			OFF	OFF	OFF	
22	36006	31.5-30.0/15.0	1.15	82.5	NEMA	78.5					
23	36009		1.15					OFF	OFF	OFF	CIRC PROVIDED TEMPORARILY BY 2 SECONDARY PUMPS W/ CROSSOVER VALVES CLOSED
24	36014	54.7-49.6/24.8	1.15	88.5	NEMA						RPT LISTS BASE BID EQP BUT ALT BID EQP INSTALLED
25	39015	140.0/70.0	1.15								
	39015	140.0/70.0	1.15								
26	39043	92.0	1.15	91.0	FACT	85.5					NO PUMP NAMEPLATE
	39043	160.0/80.0	1.15	90.7		93.3		64.0	60.0	60.0	EWP/LWP TAKEN AFTER STRAINER BLOWDOWN (CHG'D EWP 10 PSI)
27	41003		1.15								IMP OVERSIZED 1/8"
28	42000		1.15								CORRUGATED PIPE AT PUMP DISCHARGE
29	50001	38.0-36.0/18.0	1.15	88.0	FL	92.0	460	9.9	9.4	10.5	MOTOR SPEC = 37B01X48
30	50004	21.6/10.8	1.15	85.5		76.2					
	50004	21.0/10.5	1.15	82.9		80.7					PROPER IMP TRIM OF 8.35" YIELDS 370 GPM
	50004	21.6/10.8	1.15	85.5		76.2					
31	87018	146.0/73.0	1.15	91.0	FACT	80.5					
	87018	146.0/73.0	1.15	91.0	FACT	80.5					
32	91001	20.4/10.2	1.15				470	9.9	9.8	9.8	PUMP NAMEPLATE CORRODED, MOTOR HOT

APPENDIX D

Table D-5. Condenser Water Pump Nameplate and Field Measurement Data

PLANT NO	PLANT BLDG NO	MFG	MODEL [CAT, SPEC] NO	SERIAL NO	EQP YR	OPER SCHED HR/YR	SIZE	ORIENT	CPLNG	SUCT	FLOW CONFIG SUCT	FLOW CONFIG DISCH	EXIST vs 88/89	EQP YR	DSGN FLOW GPM	DSGN HEAD FT	PERF MEAS FLOW GPM	PERF CALC HEAD FT
1	121	WEINMAN	4G20-2 : 4G-401-1-2GK-2P	735680-1	81	4380	4 x 5 x 7	HOR	CLOSE	END	-	-	?	66	600	55	602	87
2	135	WEINMAN	LLB	83397	56	4380	3	HOR	SPLIT	DBL	CT-1/N	CH-1/S	?	NA	215	29	153	CAN'T
	135	PACO	10-15505-110061-2611	92R82268MR01		4380	1.5 x 2 x 5	HOR	CLOSE	END	CT-2/S	CH-2/N	NI	NI	NI	NI	NI	NI
3	194	PACO	10-40957-140001	87ETR00624		4380	4 x 5 x 9.5	HOR	CLOSE	END	-	-	SAME	73	677	NA	485	79
5	410	AURORA	411-SF	84-02967-2		4380	3 x 4 x 10B	HOR	SPLIT	DBL	CT-HDR	CH-1/N	SAME	84	330	62	333	62
	410	AURORA	411-SF	84-02967-1		4380	3 x 4 x 10B	HOR	SPLIT	DBL	CT-HDR	CH-2/S	SAME	84	330	62	324	62
6	2805	BELL & GOSSETT	1510 : Q-51192-4BB-91/8-BF-FM			4380	4 x ? x ?	HOR	SPLIT	END	-	-	SAME	61	206	55	278	86
7	5764	WEINMAN	L3	106585	60	4380	4 x 5 x 8	HOR	SPLIT	DBL	-	-	?	60	535	NA	438	63
8	5792	PACO	11-40125-046201-1852? (?=D)	GKN11251		4380	4 x 5 x 12	HOR	SPLIT	END	-	-	SAME	74	580	73	404	85
9	7050	MUELLER	4G1P-200P12	031658	86	8760	4 x 5 x 7	HOR	CLOSE	END	CT-HDR	CH-HDR	SAME	87	480	72	674	76
	7050	WEINMAN	4G20-2 : 4G-401-1-2GK-2P	735680-2	81	8760	4 x 5 x 7	HOR	CLOSE	END	CT-HDR	CH-HDR	SAME	82	480	72	737	63
10	7051	TACO	BB5008-7.00-C5B-2FL1	B7873Y	85	8760	5 x 8	HOR	SPLIT	END	CT-A/E	CH-A/S	SAME	85	500	28	584	29
	7051	TACO	BB5008-7.00-C5B-2FL1	B7873Y	85	0	5 x 8	HOR	SPLIT	END	CT-B/W	CH-B/N	SAME	85	500	28	512	32
13	14020	PACO	11-30955-733201	KX79547		4380	3 x 4 x 9	HOR	SPLIT	END	-	-	SAME	86	421	45	340	81
14	14023	PACO	11-30955-733201	ZAH1?090 (?=2)		4380	3 x 4 x 9	HOR	SPLIT	END	-	-	SAME	86	438	45	241	87
15	21002	DUNHAM-BUSH	B9TC-1	42619		4380	3	HOR	SPLIT	END	-	-	SAME	71	624	39	503	56
16	27004	PACO	29-50126-040001-1882	LHJ36148-A		4380		HOR	SPLIT	DBL	-	-	?	74	1340	NA	779	92
17	28000	PACO	29-30957-720061-A02-1	GTMF00447-A		4380	3 x 4 x 9.5	HOR	SPLIT	DBL	CT-HDR	CH-1/N	SAME	83	330	62	252	63
	28000	PACO	29-30957-720061-A02-1	GTMF00447-B		4380	3 x 4 x 9.5	HOR	SPLIT	DBL	CT-HDR	CH-2/S	SAME	83	330	62	252	63
18	29005	AURORA	411-BF	73-7741-2		4380	6 x 8 x 11	HOR	SPLIT	DBL	CT-HDR	CH-HDR	SAME	75	1422	65	1132	77
	29005	AURORA	411-BF	73-7741-1		4380	6 x 8 x 11	HOR	SPLIT	DBL	CT-HDR	CH-HDR	SAME	75	1422	65	1132	77
19	31008	AERMTR, WNMN, MDLND	6L2 : 6L2-40C-39020	C76909	83	4380	6 x 8 x 12	HOR	SPLIT	DBL	-	-	SAME	DIF	DIF	DIF	DIF	DIF
20	34008	PACO	29-50126-040001-1882	1HJ36148-B		4380		HOR	SPLIT	DBL	-	-	?	DIF	DIF	DIF	DIF	DIF
21	36000	WEINMAN	6L2	142633-3	64	8760	6 x 8 x 12	HOR	SPLIT	DBL	CT-HDR	CH-HDR	?	NI	NI	NI	CAN'T	CAN'T
	36000	WEINMAN	6L2	142633-1	63	8760	6 x 8 x 12	HOR	SPLIT	DBL	CT-HDR	CH-HDR	?	89	1200	75	CAN'T	CAN'T
	36000	WEINMAN	6L2	142633-2	63	8760	6 x 8 x 12	HOR	SPLIT	DBL	CT-HDR	CH-HDR	?	DIF	DIF	DIF	CAN'T	CAN'T
	36000	AERMTR, WNMN, MDLND	6L2 : 6L2-2	99065	88	8760	6 x 8 x 12	HOR	SPLIT	DBL	CT-HDR	CH-HDR	SAME	88	1431	80	CAN'T	CAN'T
22	36006	AURORA	OJPA-BF : 968-1450			4380	4 x 5 x 11A	HOR	SPLIT	DBL	-	-	SAME	68	813	50	483	68
24	36014	GOULDS	3656 : 3BF15035	2360012	92	8760	1.5 x 2 x 6	HOR	CLOSE	END	CT-HDR	CH-3/N	SAME	82	DIF	DIF	191	CAN'T
25	39015	AURORA	411-BF	76-366-1		4380	8 x 8 x 11B	HOR	SPLIT	DBL	CT-HDR	CH-HDR	SAME	75	1695	65	1058	82
	39015	AURORA	411-BF	76-366-2		4380	8 x 8 x 11B	HOR	SPLIT	DBL	CT-HDR	CH-HDR	SAME	75	1695	65	1058	82
26	39043	AURORA	14 RL 1110, 1 STG	V85-70561		4380		VERT	SPLIT	SUMP	CT-HDR	CH-HDR	SAME	78	1680	80	1365	90
	39043	AURORA	14 RL 1110, 1 STG	V83-72124		4380		VERT	SPLIT	SUMP	CT-HDR	CH-HDR	SAME	78	1680	80	1365	90
27	41003	DUNHAM-BUSH	B9TC-1	42618		4380	3	HOR	SPLIT	END	-	-	SAME	72	658	35	539	50
28	42000	DUNHAM-BUSH	B9TC-1	41633		4380	3	HOR	SPLIT	END	-	-	SAME	70	627	65	404	81
30	50004	PACO	29-30958-120061-1742? (?=EorF)	JLR21291-B		8760		HOR	SPLIT	DBL	CT-1/E	CH-1/M	?	82	375	65	488	29
	50004	PACO	29-30958-120061-1742? (?=EorF)	JLR21291-A		8760		HOR	SPLIT	DBL	CT-2/M	CH-2/E	?	82	375	65	279	54
	50004	AURORA	411-BF	82-17226-1		8760	3 x 4 x 10B	HOR	SPLIT	DBL	CT-3/W	CH-3/W	?	82	375	65	396	CAN'T
31	87018	AURORA	411-BF	73-7740-2		4380	6 x 8 x 11	HOR	SPLIT	DBL	CT-HDR	CH-HDR	SAME	72	1422	65	966	82
	87018	AURORA	411-BF	73-7740-1		4380	6 x 8 x 11	HOR	SPLIT	DBL	CT-HDR	CH-HDR	SAME	72	1422	65	966	82

APPENDIX D

Table D-5. Condenser Water Pump Nameplate and Field Measurement Data

PLANT NO	PLANT BLDG NO	PERF EFF %	PERF POW BHP	DSGN FLOW GPM	DSGN HEAD FT	DSGN SPD RPM	DSGN IMP DIA IN		PERF MEAS EWP PSIG		PERF MEAS LWP PSIG	PERF MEAS HEAD FT	PERF CALC FLOW GPM	MFG	MODEL NO	SERIAL NO	FRAME	DSGN POW HP	DSGN SPD RPM	DSGN POT VOLT
1	121	83	16.0	621	85	3500			CANT		CANT	—	—	U.S. ELECT		R-6127-09-732-N	254JP	20	3525	230/460
2	135	CANT	CANT	215	27	1750			CANT		17.0	—	—	U.S. ELECT		E658A/S04S0470017F	184T	5	1715	230/460
	135	NI	NI	106	58	3500	4.200	ACT	CANT		22.0	—	—	U.S. ELECT		B069/T10T199R110F	182JM	3	3490	230/460
3	194	77	12.6	684	40	1750	9.200	ACT	CANT			—	—	U.S. ELECT		B089/N06N100R164F	254JM	15	1765	230/460
5	410	81	6.3	330	62	1750					CANT	—	—	MARATHON	NVK215TTDR7026HTL		215T	10	1745	208-230/460
	410	80	6.2	330	62	1750			-12.5	"HG	25.0	72	130	MARATHON	NVK215TTDR7026HTL		215T	10	1745	208-230/460
6	2805	64	9.3	350	80	1750	9.125	MOD	CANT		CANT	—	—	DAYTON	2N939F	100112FH861	256U	10	1740	208-220/440
7	5764	81	8.6	535	60	1750			CANT		CANT	—	—	WSTNGHS		5910	256U	10	1745	208-220/440
8	5792	69	12.5	580	78	1750			CANT		21.5	—	—	U.S. ELECT		9403610-371BR21947	256T	20	1750	230/460
9	7050	81	16.1	621	85	3500			-4.0	"HG	30.0	74	685	U.S. ELECT		B048/N05N050R030F	256JP	20	3525	230/460
	7050	75	16.0	621	85	3500			0.0	"HG	30.0	69	—	U.S. ELECT		R-6127-10-157-M	254JP	20	3525	230/460
10	7051	73	5.7	500	34	1750	7.000	MOD	OFF		OFF	—	—	BALDOR	M3311T	F385	213T	7.5	1725	208-230/460
	7051	75	5.6	500	34	1750	7.000	MOD	-5.0	"HG	13.0	36	430	BALDOR	M3311T	F385	213T	7.5	1725	208-230/460
13	14020	80	8.6	500	NA	1750	9.600	ACT	-8.0	"HG	24.5	66	470	CENTURY	6-350057-40	BD9	F215T	10	1745	230/460
14	14023	73	7.3	500	NA	1750	9.600	ACT	-4.0	"HG	27.0	67	465	BALDOR	M3714T	F287	215T	10	1725	208-230/460
15	21002	76	9.6	655	37	1750	7.875	ACT	2.0	PSIG	15.5	31	760	RELIANCE		P21G5116ALU	215T	10	1750	230/460
16	27004	83	21.5	1340	50	1750			-5.0	"HG	23.0	59	1260	GOULD	6-312794-01		286T	30	1750	230/460
17	28000	70	5.8	330	62	1750	7.850	ACT	1.5	PSIG	25.5	55	345	U.S. ELECT		F-9242-05-149	215T	10	1730	230/460
	28000	70	5.8	330	62	1750	7.850	ACT	1.5	PSIG	29.0	64	230	U.S. ELECT		F-9242-05-149	215T	10	1730	230/460
18	29005	86	25.3	1422	65	1750			CANT		24.0	—	—	MARATHON	BL286TTDR7026CDW	230323	286T	30	1765	230/460
	29005	86	25.3	1422	65	1750			CANT		24.0	—	—	BALDOR	M2535T	40D01X67	286T	30	1760	230/460
19	31008	DIF	DIF	1395	31	1750			-7.0	"HG	19.0	52	860	BALDOR	M2515T	39D01X49	256T	20	1760	230/460
20	34008	DIF	DIF	1340	50	1750			CANT		16.5	—	—	GOULD	6-313037-05		286T	30	1750	460
21	36000	CANT	CANT	1200	75	1750			1.5	PSIG	28.5	62	1570	BALDOR	M4104	1/88C	326U	30	1760	208-230/460
	36000	CANT	CANT	1200	75	1750			1.5	PSIG	29.0	64	1520	MARATHON	1M326UTDR26CCWF2		326U	30	1770	208-220/440
	36000	CANT	CANT	1200	75	1750			2.0	PSIG	28.5	61	1590	MARATHON	1M326UTDR26CCWF2		326U	30	1770	208-220/440
	36000	CANT	CANT			1750			OFF		OFF	—	—	BALDOR	M2539T	10/80	324T	40	1760	230/460
22	36006	71	11.7	825	50	1750			-17.0	"HG	23.0	72	285	MARATHON	5E256TTFS7026AAW	454060	256T	20	1750	230/460
24	36014	CANT	CANT	149	55	3500	5.938	ACT	2.0	PSIG	12.5	24	190	BALDOR	JMM3212T	F1291	182JM	5	3450	208-230/460
25	39015	80	28.2	1695	65	1750			CANT		20.0	—	—	GOULD	6-313482-02		324T	40	1765	230/460
	39015	80	28.2	1695	65	1750			CANT		22.0	—	—	BALDOR	M2539T	42B01W02	324T	40	1760	230/460
26	39043	74	40.8	1680	80	1770			CANT		CANT	—	—	GEN ELECT	5K6253XL502A	MWJ1221253	C326VP16	50	1765	230/460
	39043	74	40.8	1680	80	1770			CANT		CANT	—	—	GEN ELECT	5K6253XL502A	DNJ413401	C326VP16	50	1765	230/460
27	41003	73	9.6	673	34	1750	7.750	ACT	1.5	PSIG	16.5	35	710	RELIANCE		P21G5116ALU	215T	10	1750	230/460
28	42000	72	11.6	627	65	1750	8.750	ACT	2.0	PSIG	29.5	64	720	LINCOLN		3898725TF4362	254T	15	1750	230/460
30	50004	57	6.4	325	50	1750					23.5	54	—	MARATHON	NVC215TTDR7026HTW		215T	10	1745	208-230/460
	50004	77	4.9	325	50	1750						0	—	GOULD	6-330772-02	Z7	S215T	10	1750	230/460
	50004	CANT	CANT			1750			-3.0	"HG	27.0	66	—	TOSHIBA	80104DGF24A	0Z100		10	1740	460
31	87018	82	24.2	1422	65	1750			-9.5	"HG	CANT	—	—	MARATHON	BA286TTDR7026CDW	100512	286T	30	1765	230/460
	87018	82	24.2	1422	65	1750			-6.0	"HG	24.0	62	1470	MARATHON	BA286TTDR7026CDW	100610	286T	30	1765	230/460

APPENDIX D

Table D-5. Condenser Water Pump Nameplate and Field Measurement Data

PLANT NO	PLANT BLDG NO	DSGN PH	DSGN CUR	DSGN SERV FACT	DSGN EFF	DSGN POW FACT	PERF POT	PERF CUR 1	PERF CUR 2	PERF CUR 3	NOTES
			FLA	%	%	%	VOLT	AMP	AMP	AMP	
1	121	3		1.15							
2	135	3	13.4/6.7	1.15	82.5		205	6.7	7.1	7.2	
	135	3	8.6/4.3	1.25	80.0						
3	194	3	39.2/19.6	1.25	89.5		202	35.0	35.0	35.0	STOCK PIP = 156S
5	410	3	26.6/13.3	1.15	86.5	80.2					
	410	3	26.6/13.3	1.15	86.5	80.2					
6	2805	3	27.0/13.5	1.00	87.5	82.0	475	10.9	10.9	11.5	PUMP ID = 665C29
7	5764	3		1.15							MOTOR S = 1778094
8	5792	3	54.0/27.0	1.15							
9	7050	3	49.8/24.9	1.25	88.6	88.1					DSGN EFF 87.5 NEMA (MTR) 88.5 NEMA (FACT)
	7050	3	51.7/25.9	1.15	87.5			12.5	13.2	13.5	
10	7051	3	23.0-22.0/11.0	1.15	86.0	75.0		OFF	OFF	OFF	MOTOR SPEC = 37B01X54
	7051	3	23.0-22.0/11.0	1.15	86.0	75.0					MOTOR SPEC = 37B01X54
13	14020	3	25.6/12.8	1.15	87.5	85.5					STOCK PIP = 363, MOTOR CAT = N305
14	14023	3	28.0-26.0/13.0	1.00	87.0	82.0	460	11.3	12.0	12.0	STOCK PIP = 363, MOTOR SPEC = 37A01Z50
15	21002	3	31.0/15.5	1.15							IMP OVERSIZED 1/8"
16	27004	3	74.0/37.0	1.15							
17	28000	3		1.15	84.0						PROPER IMP TRIM OF 8.10" YIELDS 400 GPM
	28000	3		1.15	84.0						PROPER IMP TRIM OF 8.10" YIELDS 305 GPM
18	29005	3	74.0/37.0	1.15	89.5	81.0					
	29005	3	74.0/37.0	1.15	91.0	83.0					
19	31008	3		1.15	88.0	83.0					
20	34008	3	37.0	1.15							
21	36000	3	85.0-80.0/40.0	1.15	92.0	85.0					MOTOR SPEC = 12C61W114
	36000	3	76.0/38.0	1.15	92.0	85.0					
	36000	3	76.0/38.0	1.15	92.0	85.0					
	36000	3	94.0/47.0	1.15	91.0	88.0		OFF	OFF	OFF	MOTOR SPEC = 42B01W02
22	36006	3		1.00	89.5	84.5					
24	36014	3	13.1-11.5/5.7	1.15	84.0	95.0					MOTOR SPEC = 36F971-106, RPT LISTS BASE BID EQP BUT ALT BID EQP INSTALLED, OPER OFF CURVE
25	39015	3		1.15							
	39015	3		1.15	91.0	88.0					CHECK VALVE MALFUNCTIONING, CW MAKE-UP CONN'D TO PUMP INLET
26	39043	3	123.8/61.9	1.15							
	39043	3	123.8/61.9	1.00							
27	41003	3		1.15							IMP OVERSIZED 1/8"
28	42000	3		1.15	85.0						IMP OVERSIZED 1/8"
30	50004	3	26.6/13.3	1.15	86.5	80.2					
	50004	3	25.0/12.5	1.15	85.6	87.5					
	50004	3	13.4								
31	87018	3	74.0/37.0	1.15	89.5	81.0					
	87018	3	74.0/37.0	1.15	89.5	81.0					

Appendix E: Analysis of Field Measurement Data

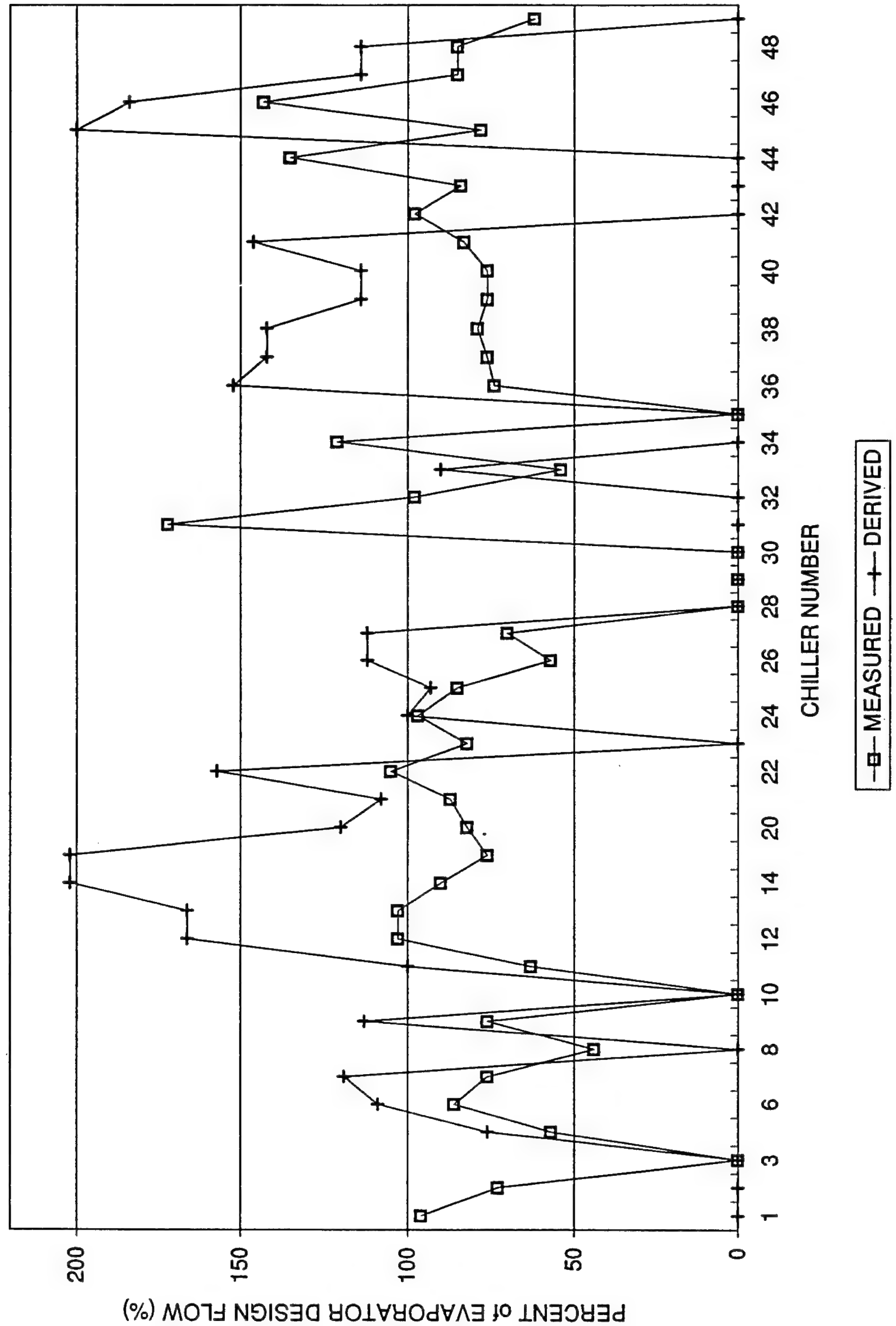


Figure E-1. Evaporator Flowrate Comparison

Figure E-2. Condenser Flowrate Comparison

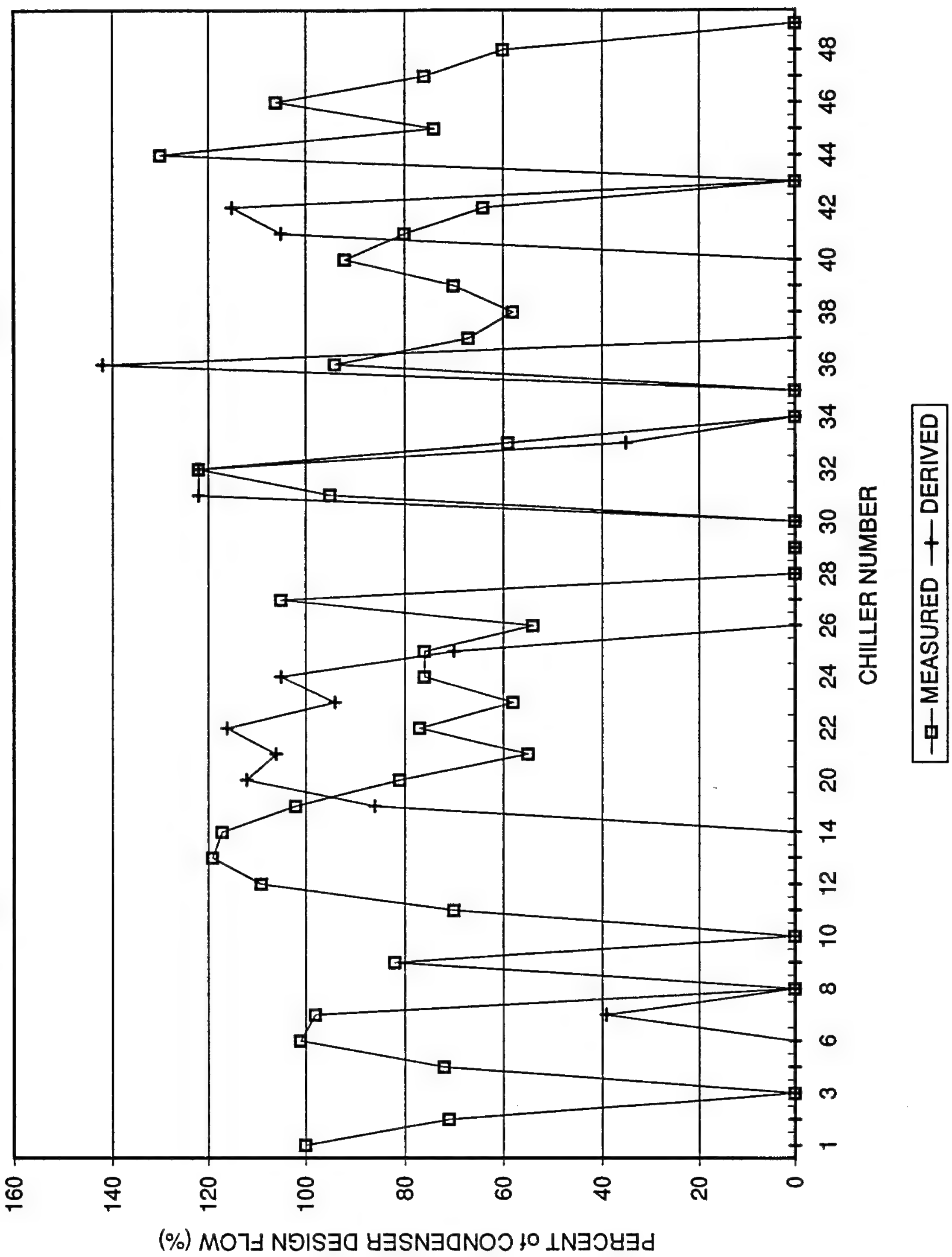
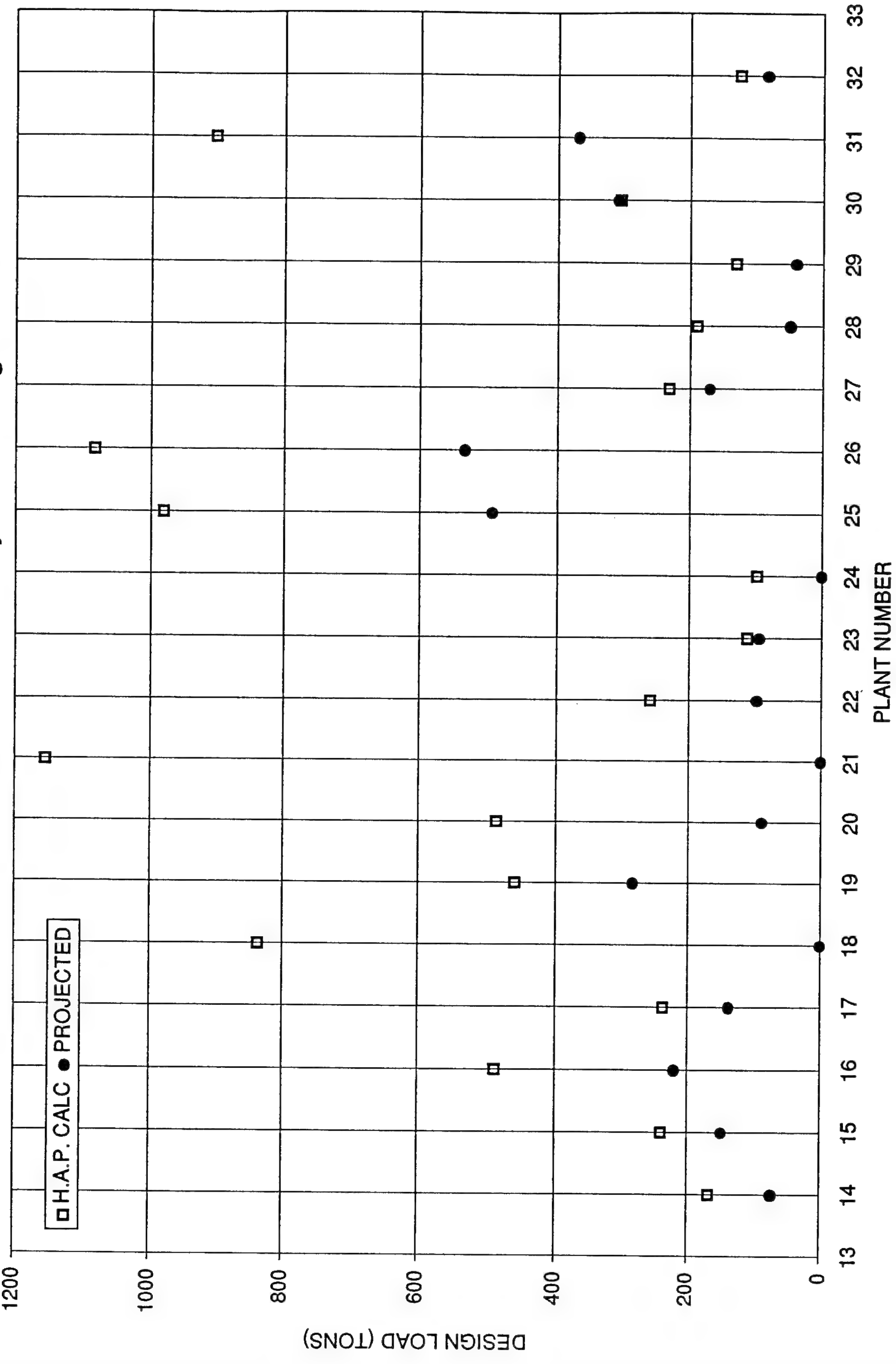


Figure E-3. "H.A.P." and Projected Design Loads



Appendix F: Derivation of Typical Cooling Load Profiles

The procedure outlined here was used to generate profiles of cooling load versus outside air temperature, and annual occurrence versus percent full load, for Building 39004, an enlisted men's barracks. These profiles were developed with simulated weather data for the months of May through October using the following procedures.

1. Reviewed and revised Carrier "Hourly Analysis Program" (HAP) version 1.10 input data furnished on floppy disk by USACERL, then converted data to version 2.01 format.

2. Ran Carrier HAP version 2.01 to obtain the maximum zone (building) cooling load, and cooling loads at 1-hour increments for 1 day in each of 6 cooling months.

3. Extracted month, time of day, outside air dry-bulb and wet-bulb temperatures, and cooling loads from HAP output, input same to Lotus "1-2-3" version 2.01 spreadsheet, then calculated percent-full-load at each 1-hour increment. See Table F1, HAP Cooling Load by Month and Time-of-Day.

4. Sorted data to obtain outside air temperatures in ascending order for each of three 8-hour time blocks (to correspond with published time/temperature/occurrence bin data).

5. Graphed percent full load versus outside air temperature, using Lotus "1-2-3" version 4.00 for each time block to determine shape of curves. Noted that each curve could be suitably represented by a linear equation. See Figure F1, HAP Cooling Load Versus Outside Air Temperature.

6. Input matrix of outside air temperature and percent full load for each time block into HP-48SX calculator, performed statistical analyses to obtain slopes and intercepts for "best-fit" linear equations, then calculated revised percent-full-load values in spreadsheet using linear equations. Noted that equations allowed extrapolation beyond outside air temperatures simulated by HAP.

Also noted that equations could be used to prorate measured chiller loads (at actual times and outside air temperatures) to design loads (at design conditions) to check sizing of chillers. See Table F2, Linear Approximation and Annual Occurrence of Cooling Load by Time Block and Outside Air Temperature, and Figure F2, Linear Approximation of Cooling Load versus Outside Air Temperature.

7. Input published hourly occurrences at 5-degree bins of outside air temperature for each time block into spreadsheet, then graphed annual occurrence versus percent full load. See "Mean Frequency of Occurrence of Dry Bulb Temperature...," an excerpt of published material included herein, and Figure F3, Annual Occurrence versus Percent Full Load (at 5-Degree Outside Air Temperature Bins).

8. Converted annual occurrence data from published 5-degree bins of outside air temperature to equivalent 10-percent bins of full load. Conversion involved interpolation of published hours to obtain hours at 10-percent full-load intervals, then multiplication of resultant hours by the ratio:

$$\frac{\text{[Summation (\% Full Load 5 °F * Annual Occurrence 5 °F)]}}{\text{[Summation (\% Full Load 10\% bins * Annual Occurrence 10\% bins)]}}$$

to counteract the inflation of total hours caused by interpolation. See TableF3, Annual Occurrence of Cooling Load by Time Block and Percent Full Load(5% Bin), and Figure F4, Annual Occurrence versus Percent Full Load (at 10% Full Load Bins).

9. Repeated step 8 to obtain equivalent 5-percent bins of full load. Noted this bin increment would be more suitable than 10-percent bins for modeling multiple chiller plants. See Table F3, Annual Occurrence of Cooling Load by Time Block and Percent Full Load (5% Bin), and Figure F5, Annual Occurrence versus Percent Full Load (at 5% Full Load Bins).

APPENDIX F

Table F-1. H.A.P. Cooling Load by Month and Time-of-Day.

Building: 39004
Max Cooling Load: 80.57 tons

month	time of day	OA DB TEMP (F)	OA WB TEMP (F)	HAP COOL LOAD (tons)	FULL LOAD (%)
MAY	0	72.9	68.0	43.42	53.9
MAY	1	71.8	67.6	36.81	45.7
MAY	2	70.6	67.3	29.03	36.0
MAY	3	69.7	67.0	21.75	27.0
MAY	4	69.0	66.8	18.97	23.5
MAY	5	68.8	66.7	17.96	22.3
MAY	6	69.3	66.8	25.31	31.4
MAY	7	70.4	67.2	34.23	42.5
MAY	8	72.5	67.8	37.20	46.2
MAY	9	75.5	68.7	40.27	50.0
MAY	10	78.9	69.8	43.18	53.6
MAY	11	82.8	70.9	48.03	59.6
MAY	12	86.5	71.9	54.09	67.1
MAY	13	89.3	72.7	58.19	72.2
MAY	14	91.1	73.2	62.11	77.1
MAY	15	91.8	73.4	65.01	80.7
MAY	16	91.1	73.2	66.09	82.0
MAY	17	89.5	72.8	65.48	81.3
MAY	18	87.0	72.1	63.38	78.7
MAY	19	84.0	71.2	61.19	75.9
MAY	20	81.0	70.4	58.15	72.2
MAY	21	78.5	69.6	56.35	69.9
MAY	22	76.2	69.0	53.76	66.7
MAY	23	74.3	68.4	48.13	59.7

month	time of day	OA DB TEMP (F)	OA WB TEMP (F)	HAP COOL LOAD (tons)	FULL LOAD (%)
JUN	0	77.5	70.2	52.45	65.1
JUN	1	76.4	69.9	46.00	57.1
JUN	2	75.2	69.5	38.27	47.5
JUN	3	74.3	69.3	31.37	38.9
JUN	4	73.6	69.1	28.75	35.7
JUN	5	73.4	69.0	27.80	34.5
JUN	6	73.9	69.1	34.94	43.4
JUN	7	75.0	69.5	43.46	53.9
JUN	8	77.1	70.1	46.40	57.6
JUN	9	80.1	70.9	49.43	61.4
JUN	10	83.5	71.9	52.40	65.0
JUN	11	87.4	73.0	57.14	70.9
JUN	12	91.1	74.0	62.91	78.1
JUN	13	93.9	74.7	67.06	83.2
JUN	14	95.7	75.2	71.09	88.2
JUN	15	96.4	75.4	73.90	91.7
JUN	16	95.7	75.2	74.89	93.0
JUN	17	94.1	74.8	74.26	92.2
JUN	18	91.6	74.1	72.39	89.8
JUN	19	88.6	73.3	70.13	87.0
JUN	20	85.6	72.5	67.09	83.3
JUN	21	83.1	71.8	65.41	81.2
JUN	22	80.8	71.1	62.67	77.8
JUN	23	78.9	70.6	57.16	70.9

month	time of day	OA DB TEMP (F)	OA WB TEMP (F)	HAP COOL LOAD (tons)	FULL LOAD (%)
JUL	0	80.1	72.0	57.96	71.9
JUL	1	79.0	71.7	51.53	64.0
JUL	2	77.8	71.4	43.94	54.5
JUL	3	76.9	71.1	37.01	45.9
JUL	4	76.2	70.9	34.43	42.7
JUL	5	76.0	70.8	33.50	41.6
JUL	6	76.5	71.0	40.38	50.1
JUL	7	77.6	71.3	48.91	60.7
JUL	8	79.7	71.9	51.90	64.4
JUL	9	82.7	72.7	54.91	68.2
JUL	10	86.1	73.7	57.84	71.8
JUL	11	90.0	74.7	62.62	77.7
JUL	12	93.7	75.7	68.71	85.3
JUL	13	96.5	76.4	72.79	90.3
JUL	14	98.3	76.8	76.63	95.1
JUL	15	99.0	77.0	79.53	98.7
JUL	16	98.3	76.8	80.57	100.0
JUL	17	96.7	76.4	79.88	99.1
JUL	18	94.2	75.8	77.86	96.6
JUL	19	91.2	75.0	75.71	94.0
JUL	20	88.2	74.2	72.59	90.1
JUL	21	85.7	73.5	70.85	87.9
JUL	22	83.4	72.9	68.21	84.7
JUL	23	81.5	72.4	62.69	77.8

APPENDIX F

Table F-1. H.A.P. Cooling Load by Month and Time-of-Day.

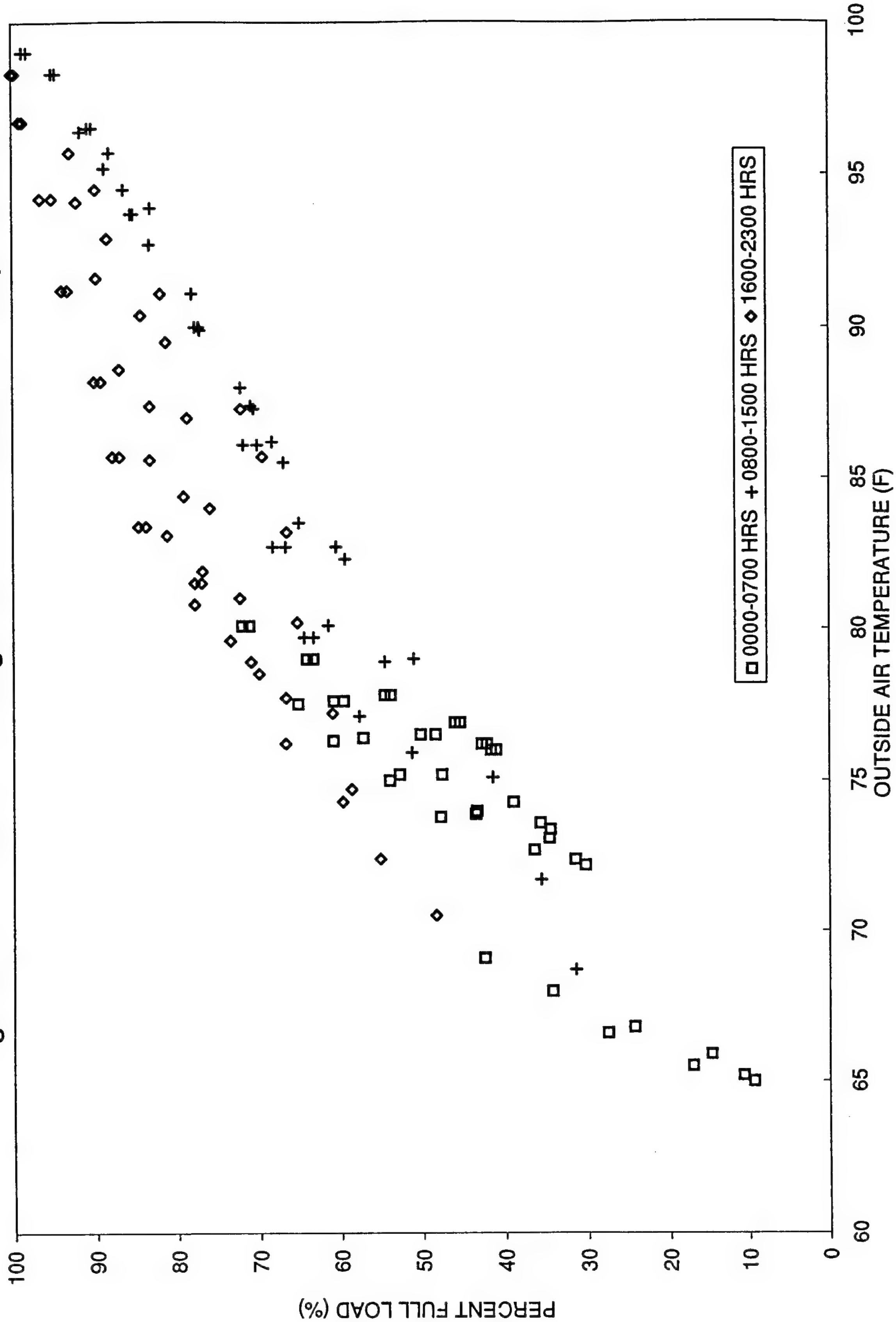
Building: 39004
Max Cooling Load: 80.57 tons

month	time of day	OA DB TEMP (F)	OA WB TEMP (F)	HAP COOL LOAD (tons)	FULL LOAD (%)
AUG	0	80.1	72.0	57.30	71.1
AUG	1	79.0	71.7	50.92	63.2
AUG	2	77.8	71.4	43.37	53.8
AUG	3	76.9	71.1	36.46	45.3
AUG	4	76.2	70.9	33.92	42.1
AUG	5	76.0	70.8	33.03	41.0
AUG	6	76.5	71.0	38.94	48.3
AUG	7	77.6	71.3	47.96	59.5
AUG	8	79.7	71.9	50.89	63.2
AUG	9	82.7	72.7	53.64	66.6
AUG	10	86.1	73.7	56.47	70.1
AUG	11	90.0	74.7	62.23	77.2
AUG	12	93.7	75.7	68.94	85.6
AUG	13	96.5	76.4	73.13	90.8
AUG	14	98.3	76.8	76.29	94.7
AUG	15	99.0	77.0	79.16	98.2
AUG	16	98.3	76.8	80.30	99.7
AUG	17	96.7	76.4	79.53	98.7
AUG	18	94.2	75.8	76.73	95.2
AUG	19	91.2	75.0	75.18	93.3
AUG	20	88.2	74.2	71.95	89.3
AUG	21	85.7	73.5	70.13	87.0
AUG	22	83.4	72.9	67.48	83.8
AUG	23	81.5	72.4	61.98	76.9

month	time of day	OA DB TEMP (F)	OA WB TEMP (F)	HAP COOL LOAD (tons)	FULL LOAD (%)
SEP	0	76.3	69.8	48.98	60.8
SEP	1	75.2	69.4	42.48	52.7
SEP	2	74.0	69.1	34.87	43.3
SEP	3	73.1	68.8	27.85	34.6
SEP	4	72.4	68.6	25.26	31.4
SEP	5	72.2	68.5	24.36	30.2
SEP	6	72.7	68.6	29.35	36.4
SEP	7	73.8	69.0	38.46	47.7
SEP	8	75.9	69.6	41.26	51.2
SEP	9	78.9	70.5	43.92	54.5
SEP	10	82.3	71.5	47.78	59.3
SEP	11	86.2	72.6	55.03	68.3
SEP	12	89.9	73.6	62.12	77.1
SEP	13	92.7	74.4	67.14	83.3
SEP	14	94.5	74.8	69.72	86.5
SEP	15	95.2	75.0	71.56	88.8
SEP	16	94.5	74.8	72.42	89.9
SEP	17	92.9	74.4	71.28	88.5
SEP	18	90.4	73.7	67.97	84.4
SEP	19	87.4	72.9	67.08	83.3
SEP	20	84.4	72.1	63.75	79.1
SEP	21	81.9	71.4	61.88	76.8
SEP	22	79.6	70.7	59.11	73.4
SEP	23	77.7	70.2	53.63	66.6

month	time of day	OA DB TEMP (F)	OA WB TEMP (F)	HAP COOL LOAD (tons)	FULL LOAD (%)
OCT	0	69.1	65.7	34.13	42.4
OCT	1	68.0	65.3	27.52	34.2
OCT	2	66.8	65.0	19.55	24.3
OCT	3	65.9	64.7	11.75	14.6
OCT	4	65.2	64.4	8.58	10.6
OCT	5	65.0	64.4	7.53	9.3
OCT	6	65.5	64.5	13.69	17.0
OCT	7	66.6	64.9	22.12	27.5
OCT	8	68.7	65.6	25.31	31.4
OCT	9	71.7	66.5	28.67	35.6
OCT	10	75.1	67.6	33.39	41.4
OCT	11	79.0	68.8	41.12	51.0
OCT	12	82.7	69.9	48.63	60.4
OCT	13	85.5	70.7	53.88	66.9
OCT	14	87.3	71.2	56.77	70.5
OCT	15	88.0	71.4	58.11	72.1
OCT	16	87.3	71.2	58.08	72.1
OCT	17	85.7	70.7	56.02	69.5
OCT	18	83.2	70.0	53.59	66.5
OCT	19	80.2	69.1	52.52	65.2
OCT	20	77.2	68.2	49.05	60.9
OCT	21	74.7	67.5	47.20	58.6
OCT	22	72.4	66.7	44.38	55.1
OCT	23	70.5	66.2	38.88	48.3

Figure F-1. "H.A.P." Cooling Load vs Outside Air Temperature



APPENDIX F

Table F-2. Linear Approximation and Annual Occurance of Cooling Load

OA DB TEMP BIN	OA DB TEMP	% FULL LOAD (BEST-FIT LINEAR EQN)			ANNUAL OCCURRENCE (5-DEG BIN FOR 6 MO)			% FULL LOAD times ANNUAL OCCURRENCE		
		00-07	08-15	16-23	00-07	08-15	16-23	00-07	08-15	16-23
F	F	%	%	%	HR/YR	HR/YR	HR/YR			
SLOPE	>>>	3.3	2.0	1.7						
INTERCEPT	>>>	-196.2	-104.5	-61.2						
0% TEMP	>>>	60.4	51.7	37.1						
100% TEMP	>>>	91.1	101.2	97.7						
35-39	37			-0.1	0	0	0			
40-44	42			8.1	4	0	0			0
45-49	47		-9.6	16.4	17	3	5			82
50-54	52		0.6	24.6	45	5	10		3	246
55-59	57	-11.0	10.7	32.9	88	11	32		118	1053
60-64	62	5.3	20.8	41.1	130	36	70	689	749	2877
65-69	67	21.5	30.9	49.4	237	77	121	5096	2379	5977
70-74	72	37.8	41.0	57.6	452	139	239	17086	5699	13766
75-79	77	54.0	51.1	65.9	399	217	292	21546	11089	19243
80-84	82	70.3	61.2	74.1	96	302	299	6749	18482	22156
85-89	87	86.5	71.3	82.4	5	317	215	433	22602	17716
90-94	92	102.8	81.4	90.6	0	251	133	0	20431	12050
95-99	97	119.0	91.5	98.9	0	97	50	0	8876	4945
100-104	102	135.3	101.6	107.1	0	17	8	0	1727	857
105-109	107	151.5	111.7	115.4	0	1	1	0	112	115
110-114	112	167.8	121.8	123.6	0	0	0	0	0	0
					1319	1470	1475	51597	92267	101083
					1473	1473	1475			
					AVG %FL		>>	39.1	62.8	68.5
					AVG %FL (6 MO)		>>			57.4
					EQUIV FL HR/YR		>>	516	923	1011
					EQUIV FL HR/YR (6 MO)		>>			2449

Figure F-2. Linear Approximation of Cooling Load vs Outside Air Temp

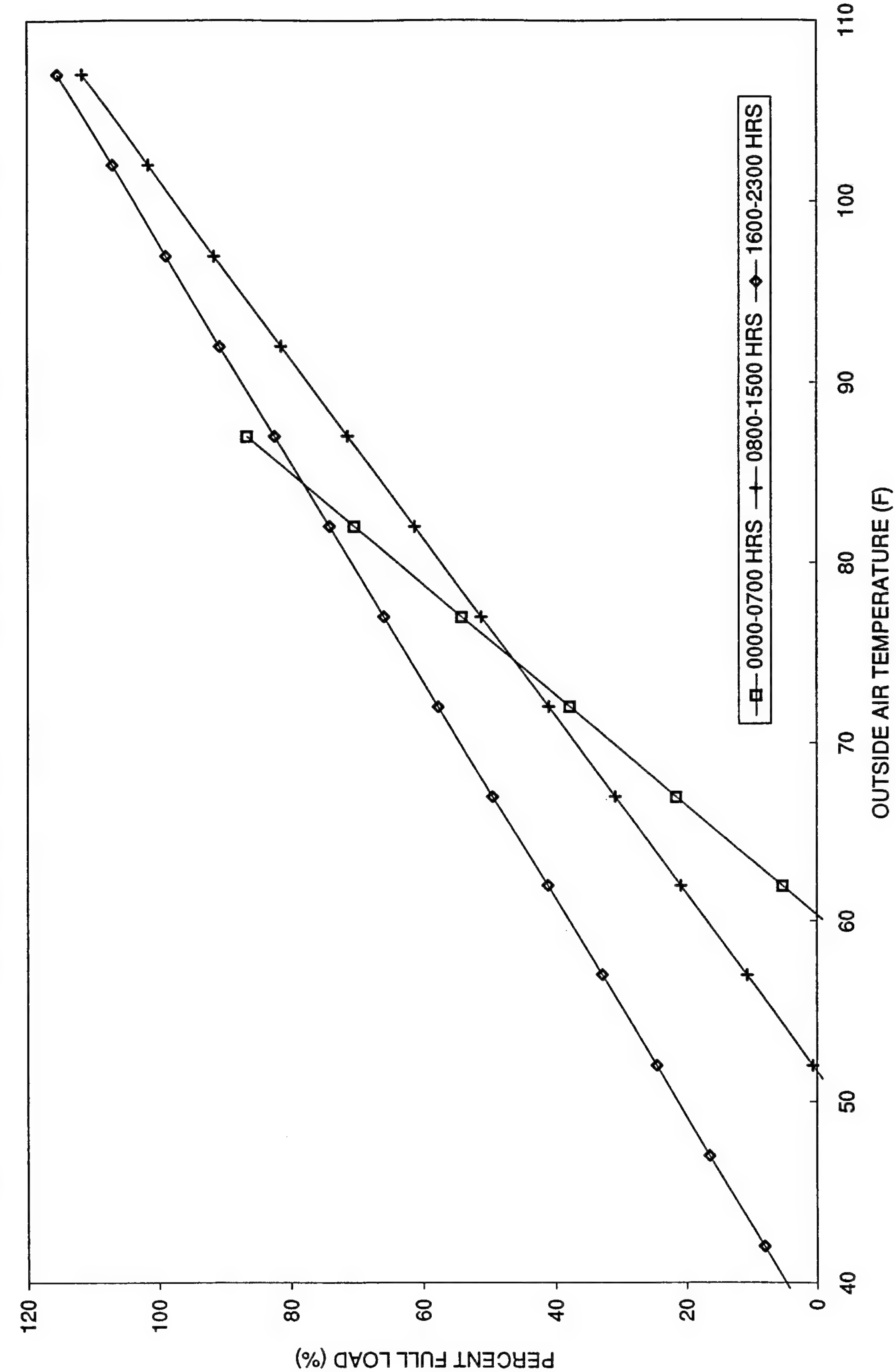
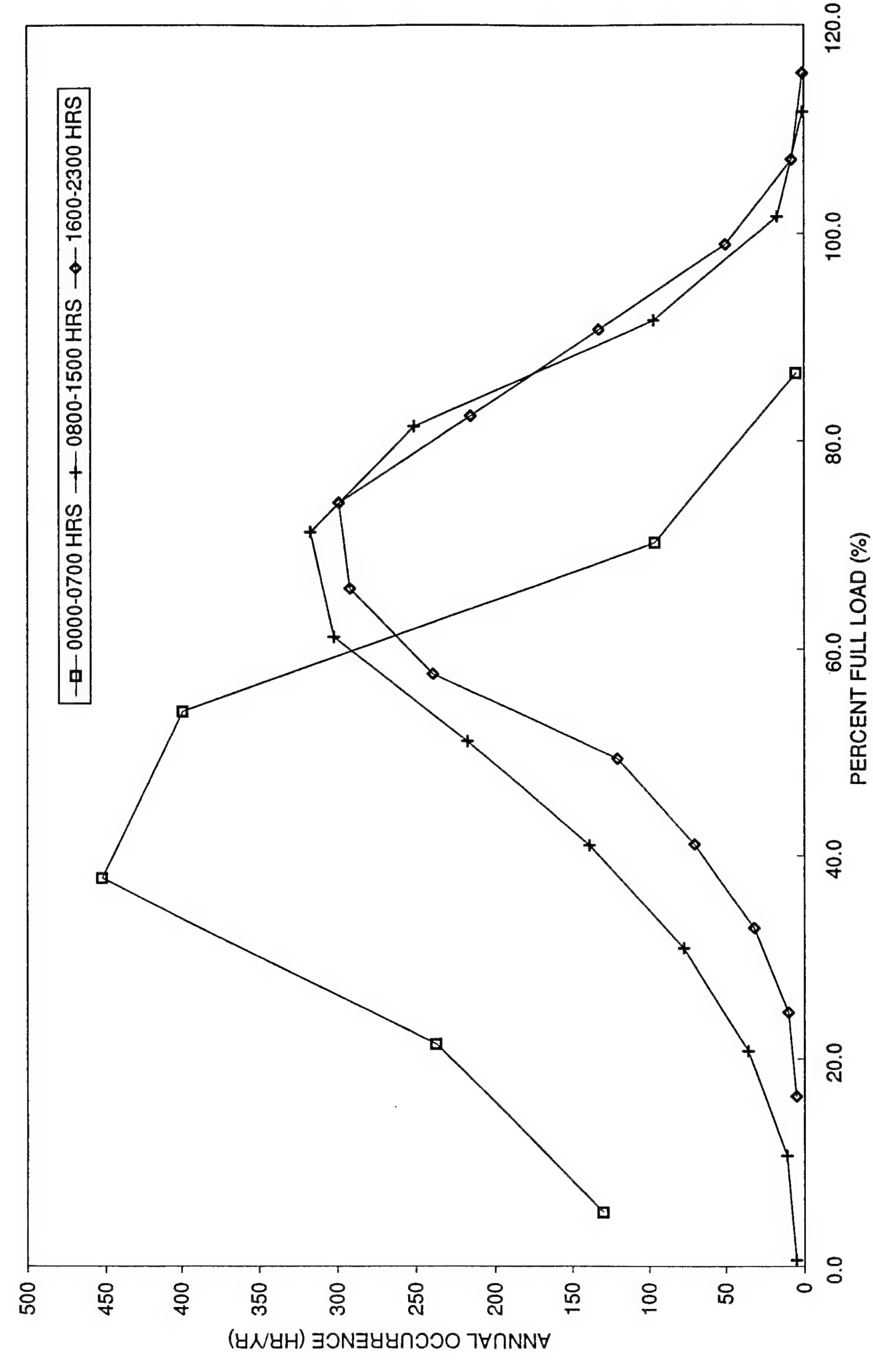


Figure F-3. Annual Occurance vs % Full Load (@ 5-deg. O.A.T. Bins)



APPENDIX F

Table F-3. Annual Occurance of Cooling Load by Time Block & Percent full Load (5% bins)

% Full Load (5% bins)	Annual Occurance (equivalant hours/year)			
	00-07	08-15	16-23	TOTAL
3	34	3	0	37
8	45	5	0	50
13	55	8	2	65
18	65	14	4	83
23	79	22	5	106
28	99	32	12	143
33	119	45	20	184
38	138	60	34	232
43	133	76	50	259
48	128	96	68	292
53	123	115	105	343
58	99	136	146	381
63	71	151	166	388
68	42	154	178	374
73	25	151	181	357
78	16	135	157	308
83	8	112	127	247
88	1	74	96	171
93	1	42	66	109
98	0	23	36	59
103	0	7	18	25
108	0	3	4	7
113	0	0	2	2
118	0	0	0	0
	1281	1464	1477	4222

Figure F-4. Annual Occurance vs % Full Load (@ 10% Full Load Bins)

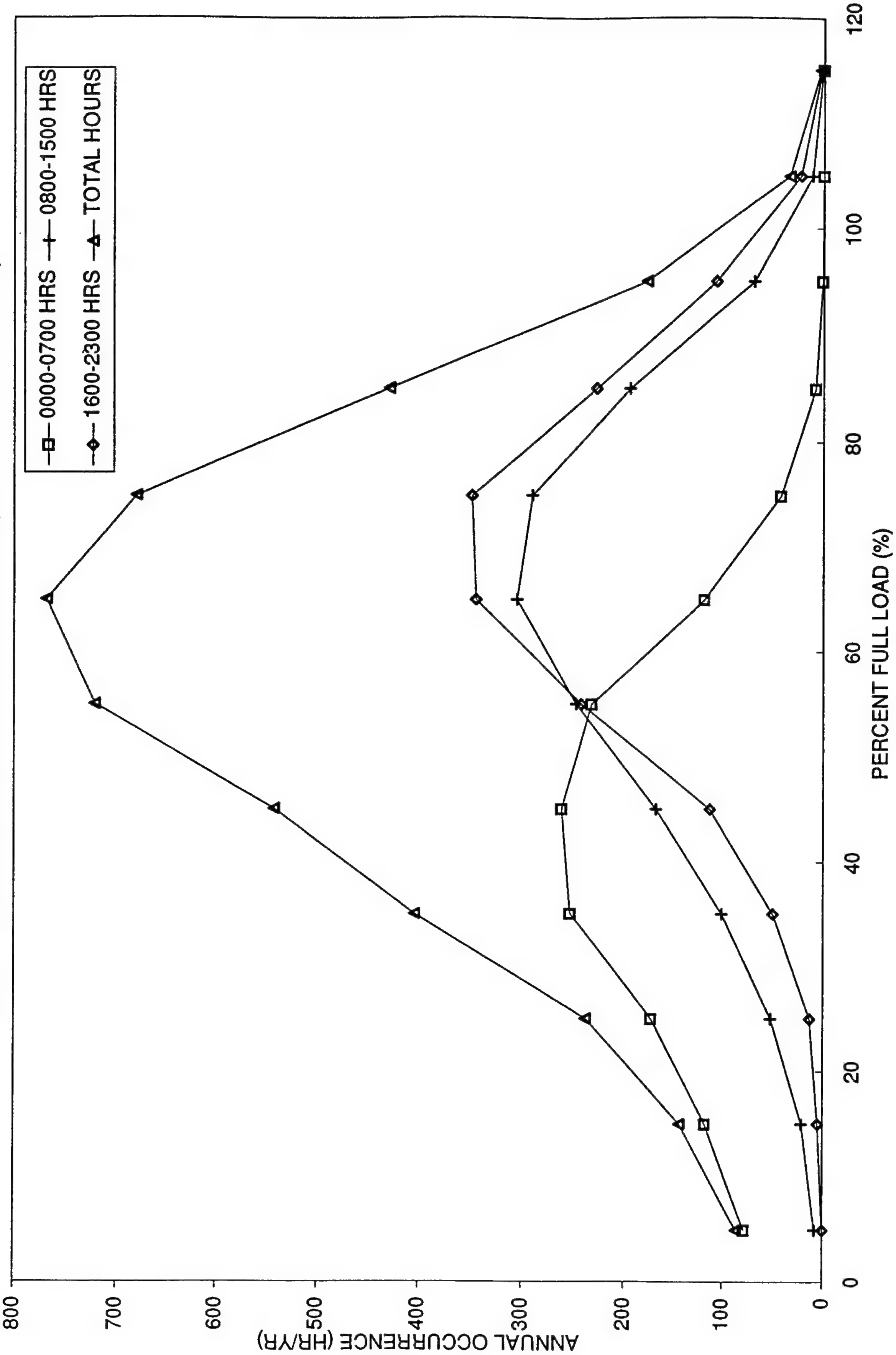
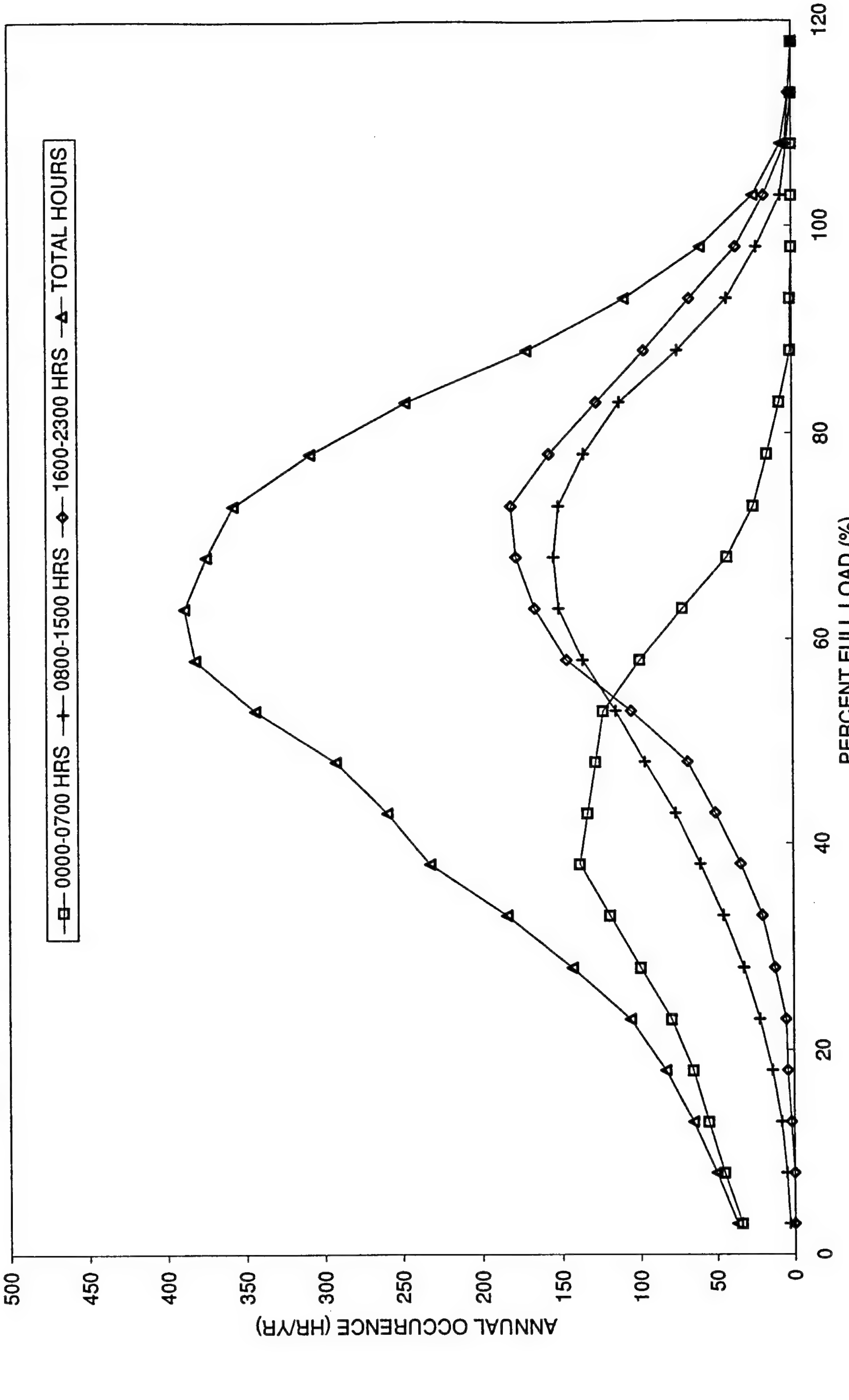


Figure F-5. Annual Occurance vs % Full Load (@5% Full Load Bins)



Appendix G: Comparison of Alternate Types of Chillers and Cooling Towers

APPENDIX G

Table G-1. Comparison of Alternate Chiller Types by Installed Cost and Full Load Efficiency

ARI cap tons	Conp/Cond	Refrig	Model	TOTAL COST ($) mat'l	labor	equip	total	UNIT COST ($/TON) mat'l	labor	eqp	total	conn load kW	Efficiency (kW/ton) full load	IPLV
104	recip-air	22	YCA	32815	9628	257	42700	315	92	2	410	131	1.260	NA
131	recip-air	22	YCA	39041	12306	744	52091	298	94	6	398	165	1.256	NA
161	recip-air	22	YCA	49482	14402	863	64747	308	90	5	403	199	1.236	NA
105	recip-wat	22	YCW	26022	8125	490	34637	248	77	5	330	90	0.854	NA
123	recip-wat	22	YCW	31546	9456	569	41571	258	77	5	339	106	0.861	NA
133	recip-wat	22	YCW	34342	9824	604	44770	258	74	5	337	109	0.822	NA
156	recip-wat	22	YCW	39752	10973	690	51415	254	70	4	329	127	0.813	NA
185	recip-wat	22	YCW	44493	12599	764	57856	240	68	4	312	157	0.848	NA
211	recip-wat	22	YCW	49649	14011	846	64506	235	66	4	305	178	0.842	NA
125	cent-wat	123	YT	51541	16058	0	67599	412	128	0	541	85	0.680	0.666
150	cent-wat	123	YT	53285	18917	0	72202	355	126	0	481	98	0.653	0.653
225	cent-wat	123	YT	59734	25441	0	85175	265	113	0	379	155	0.689	0.666
250	cent-wat	123	YT	61705	26599	0	88304	247	106	0	353	179	0.716	0.659
400	cent-wat	123	YT	92327	33544	0	125871	231	84	0	315	230	0.575	0.557
500	cent-wat	123	YT	100560	37587	0	138147	201	75	0	276	297	0.594	0.554
550	cent-wat	123	YT	106765	39609	0	146374	194	72	0	266	339	0.616	0.562
600	cent-wat	123	YT	113633	41630	0	155263	189	69	0	259	365	0.608	0.566
600	cent-wat	22	YK	123421	41630	0	165051	206	69	0	275	373	0.622	0.634
400	screw-wat	22	YS	114668	33544	0	148212	287	84	0	371	256	0.640	0.617
500	screw-wat	22	YS	100536	37587	0	138123	201	75	0	276	310	0.620	0.583
600	screw-wat	22	YS	132295	41630	0	173925	220	69	0	290	367	0.612	0.570

APPENDIX G

Table G-2. Comparison of Alternate Chiller Types by Partial Load Efficiency

Conp-Cond	Refrig	Model	Part Load Cap tons	Part Load Power kW	%FL Cap %	%FL Power %	DISPL %	ECWT F	OPT STG
CENT-WAT		GENERIC			100	100	NA	85.0	NA
					98	96	NA	84.5	NA
					93	89	NA	83.3	NA
					88	82	NA	82.0	NA
					83	76	NA	80.8	NA
					78	70	NA	79.5	NA
					73	64	NA	78.3	NA
					68	59	NA	77.0	NA
					63	54	NA	75.8	NA
					58	49	NA	74.5	NA
					53	44	NA	73.3	NA
					48	40	NA	72.0	NA
					43	36	NA	70.8	NA
					38	32	NA	69.5	NA
					33	28	NA	68.3	NA
					28	25	NA	67.0	NA
RECIP-WAT	22	YCW	105.1	89.8	100.0	100.0	100	85.0	
			91.3	72.5	86.9	80.7	83	80.8	
			77.6	55.7	73.8	62.0	67	76.7	
			60.3	40.9	57.4	45.5	50	72.5	YES
			54.0	39.5	51.4	44.0	50	72.5	
			40.1	24.9	38.2	27.7	33	68.3	
			22.2	12.6	21.1	14.0	17	64.2	YES
RECIP-WAT	22	YCW	122.5	105.5	100.0	100.0	100	85.0	
			106.0	85.0	86.5	80.6	83	80.8	
			89.8	65.1	73.3	61.7	67	76.7	
			69.7	47.7	56.9	45.2	50	72.5	YES
			63.3	46.3	51.7	43.9	50	72.5	
			46.7	29.1	38.1	27.6	33	68.3	
			25.6	14.7	20.9	13.9	17	64.2	YES
RECIP-WAT	22	YCW	133.0	109.3	100.0	100.0	100	85.0	YES
			118.2	92.4	88.9	84.5	86	82.0	YES
			106.2	81.1	79.8	74.2	75	79.0	YES
			88.7	66.5	66.7	60.8	61	75.0	YES
			57.0	43.4	42.9	39.7	46	72.0	YES
			46.2	32.6	34.7	29.8	34	69.0	YES
			33.3	22.9	25.0	21.0	23	66.0	YES

APPENDIX G

Table G-2. Comparison of Alternate Chiller Types by Partial Load Efficiency

Conp-Cond	Refrig	Model	Part Load Cap tons	Part Load Power kW	%FL Cap %	%FL Power %	DISPL %	ECWT F	OPT STG
RECIP-WAT	22	YCW	156.4	127.1	100.0	100.0	100	85.0	YES
			130.1	103.6	83.2	81.5	82	81.0	YES
			115.1	89.7	73.6	70.6	70	78.0	YES
			85.1	63.4	54.4	49.9	52	73.0	YES
			66.8	51.7	42.7	40.7	46	72.0	YES
			54.0	37.4	34.5	29.4	34	69.0	YES
			38.8	25.8	24.8	20.3	23	66.0	YES
RECIP-WAT	22	YCW	185.4	157.2	100.0	100.0	100	85.0	
			162.1	126.4	87.4	80.4	82	81.0	
			142.0	105.2	76.6	66.9	67	77.0	
			106.5	73.9	57.4	47.0	48	72.0	
			91.6	63.9	49.4	40.6	46	72.0	
			67.7	41.2	36.5	26.2	30	68.0	
			37.4	22.5	20.2	14.3	15	64.0	
RECIP-WAT	22	YCW	211.4	177.9	100.0	100.0	100	85.0	
			190.5	149.4	90.1	84.0	83	81.0	
			166.4	127.2	78.7	71.5	67	77.0	
			116.0	88.1	54.9	49.5	50	73.0	
			105.7	82.2	50.0	46.2	50	73.0	
			78.1	51.2	36.9	28.8	33	68.0	
			43.2	28.6	20.4	16.1	17	64.0	

APPENDIX G

Table G-3. Comparison of Alternate Chiller Types by Interpolated Partial Load Efficiency

TYPE :		Cent-wat	Reciprocating Compressor - Water Cooled Condenser, R-22						
FL CAP:		GENERIC	AVERAGE	105.1	122.5	133.0	156.4	185.4	211.4
%Full Load Capacity		Percent Full Load Power							
BIN 05%	BIN 10%	(INTER) %	(AVERAGE) %	(INTER) %	(INTER) %	(INTER) %	(INTER) %	(INTER) %	(INTER) %
28		25	21	20	20	24	23	20	22
30		26	23	21	21	26	25	22	24
33		28	26	24	24	28	28	24	26
38		32	30	28	28	34	34	28	30
43		36	36	34	33	40	41	33	37
48		40	42	40	39	44	45	39	44
53		44	46	44	44	49	49	43	48
58		49	50	46	46	53	54	48	52
63		54	55	51	51	58	59	53	57
68		59	60	56	56	62	65	58	62
73		64	65	61	61	67	70	63	66
78		70	71	68	68	72	76	69	71
83		76	77	75	76	78	81	75	76
88		82	83	82	83	83	87	81	82
93		89	90	90	90	90	92	89	89
98		96	97	97	97	97	98	97	97
100		100	100	100	100	100	100	100	100
	30	26	23	21	21	26	25	22	24
	35	30	27	25	25	31	31	25	28
	45	38	39	36	36	42	43	36	40
	55	46	48	45	45	50	51	45	50
	65	56	57	53	53	59	61	55	59
	75	66	67	64	64	69	72	65	68
	85	78	79	78	79	80	84	78	78
	95	92	93	93	93	93	95	92	92
	100	100	100	100	100	100	100	100	100

APPENDIX G

Table G-4. Payback Comparison of Reciprocating vs. Centrifugal Water Cooled Chillers

FIX %FL Capacity bin 05% %	FIX %FL Cap bin 10% %	OUT Load tons	FIX Annual Occur (equiv) TOTAL hr/yr	IN %FL Power %	OUT PL Effic kW/ton	OUT Power kW	OUT Energy Consum Option 1 kWh/yr	IN %FL Power %	OUT PL Effic kW/ton	OUT power kW	OUT Energy Consum Option 2 kWh/yr
Type:				RECIP-WAT				CENT-WAT			
Refrig:				R-22				R-123			
Installed Cost:				$339 /ton				$541 /ton			
bin (5/10 ?):				10				10			
FL Values:		125				106.3				85.0	
30 - (EQ)		38	310	23	0.000	0.0	0	26	0.000	0.0	0
33		41	184	26	0.000	0.0	0	28	0.000	0.0	0
38		48	232	30	0.000	0.0	0	32	0.000	0.0	0
43		54	259	36	0.000	0.0	0	36	0.000	0.0	0
48		60	292	42	0.000	0.0	0	40	0.000	0.0	0
53		66	343	46	0.000	0.0	0	44	0.000	0.0	0
58		73	381	50	0.000	0.0	0	49	0.000	0.0	0
63		79	388	55	0.000	0.0	0	54	0.000	0.0	0
68		85	374	60	0.000	0.0	0	59	0.000	0.0	0
73		91	357	65	0.000	0.0	0	64	0.000	0.0	0
78		98	308	71	0.000	0.0	0	70	0.000	0.0	0
83		104	247	77	0.000	0.0	0	76	0.000	0.0	0
88		110	171	83	0.000	0.0	0	82	0.000	0.0	0
93		116	109	90	0.000	0.0	0	89	0.000	0.0	0
98		123	59	97	0.000	0.0	0	96	0.000	0.0	0
100 >(ACT)		125	34	100	0.000	0.0	0	100	0.000	0.0	0
	30 - (EQ)	38	285	23	0.196	7.4	2109	26	0.178	6.7	1910
	35	44	404	27	0.233	10.2	4121	30	0.201	8.8	3555
	45	56	542	39	0.328	18.5	10027	38	0.256	14.4	7805
	55	69	721	48	0.405	27.9	20116	46	0.313	21.5	15502
	65	81	768	57	0.483	39.3	30182	56	0.381	31.0	23808
	75	94	680	67	0.571	53.6	36448	66	0.452	42.4	28832
	85	106	429	79	0.674	71.6	30716	78	0.533	56.7	24324
	95	119	177	93	0.789	93.7	16585	92	0.624	74.1	13116
	100 >(ACT)	125	37	100	0.850	106.3	3933	100	0.680	85.0	3145
							154237				121997
energy cost:		$0.024	/kWh				$3,702 /yr				$2,928 /YR
demand cost:		$152.60	/kW-yr				$16,214 /yr				$12,971 /YR
power cost:							$19,916 /yr				$15,899 /YR
installed cost:							$42,375				$67,625

OPT 2 vs OPT 1

diff install cost:	$25,250	
diff power cost:	($4,017) /YR	
simple payback:	6.3 yr	(w/o Utility Rebate)

APPENDIX G

Table G-4. Payback Comparison of Reciprocating vs. Centrifugal Water Cooled Chillers

FIX %FL Capacity bin 05%	FIX %FL Cap bin 10%	OUT Load	FIX Annual Occur (equiv) TOTAL	IN %FL Power	OUT PL Effic	OUT Power	OUT Energy Consum Option 1	IN %FL Power	OUT PL Effic	OUT power	OUT Energy Consum Option 2
%	%	tons	hr/yr	%	kW/ton	kW	kWh/yr	%	kW/ton	kW	kWh/yr
Type:				RECIP-WAT				CENT-WAT			
Refrig:				R-22				R-123			
Installed Cost:				$318 /ton				$447 /ton			
bin (5/10 ?):				10				10			
FL Values:		175				148.8				119.0	
30 - (EQ)		38	310	23	0.000	0.0	0	26	0.000	0.0	0
33		41	184	26	0.000	0.0	0	28	0.000	0.0	0
38		48	232	30	0.000	0.0	0	32	0.000	0.0	0
43		54	259	36	0.000	0.0	0	36	0.000	0.0	0
48		60	292	42	0.000	0.0	0	40	0.000	0.0	0
53		66	343	46	0.000	0.0	0	44	0.000	0.0	0
58		73	381	50	0.000	0.0	0	49	0.000	0.0	0
63		79	388	55	0.000	0.0	0	54	0.000	0.0	0
68		85	374	60	0.000	0.0	0	59	0.000	0.0	0
73		91	357	65	0.000	0.0	0	64	0.000	0.0	0
78		98	308	71	0.000	0.0	0	70	0.000	0.0	0
83		104	247	77	0.000	0.0	0	76	0.000	0.0	0
88		110	171	83	0.000	0.0	0	82	0.000	0.0	0
93		116	109	90	0.000	0.0	0	89	0.000	0.0	0
98		123	59	97	0.000	0.0	0	96	0.000	0.0	0
100 >(ACT)		125	34	100	0.000	0.0	0	100	0.000	0.0	0
	30 - (EQ)	38	285	23	0.196	7.4	2109	26	0.178	6.7	1910
	35	44	404	27	0.233	10.2	4121	30	0.201	8.8	3555
	45	56	542	39	0.328	18.5	10027	38	0.256	14.4	7805
	55	69	721	48	0.405	27.9	20116	46	0.313	21.5	15502
	65	81	768	57	0.483	39.3	30182	56	0.381	31.0	23808
	75	94	680	67	0.571	53.6	36448	66	0.452	42.4	28832
	85	106	429	79	0.674	71.6	30716	78	0.533	56.7	24324
	95	119	177	93	0.789	93.7	16585	92	0.624	74.1	13116
	100 >(ACT)	125	37	100	0.850	106.3	3933	100	0.680	85.0	3145
							154237				121997
energy cost:		$0.024 /kWh					$3,702 /yr				$2,928 /YR
demand cost:		$152.60 /kW-yr					$22,699 /yr				$18,159 /YR
power cost:							$26,401 /yr				$21,087 /YR
installed cost:							$55,650				$78,225

OPT 2 vs OPT 1

diff install cost: $22,575
diff power cost: ($5,314) /YR
simple payback: 4.2 yr (w/o Utility Rebate)

APPENDIX G

Table G-4. Payback Comparison of Reciprocating vs. Centrifugal Water Cooled Chillers

FIX %FL Capacity bin 05% %	FIX %FL Cap bin 10% %	OUT Load tons	FIX Annual Occur (equiv) TOTAL hr/yr	IN %FL Power %	OUT PL Effic kW/ton	OUT Power kW	OUT Energy Consum Option 1 kWh/yr	IN %FL Power %	OUT PL Effic kW/ton	OUT power kW	OUT Energy Consum Option 2 kWh/yr
Type:				RECIP-WAT				CENT-WAT			
Refrig:				R-22				R-123			
Installed Cost:				$308 /ton				$413 /ton			
bin (5/10 ?):				10				10			
FL Values:		200				170.0				136.0	
30 - (EQ)		38	310	23	0.000	0.0	0	26	0.000	0.0	0
33		41	184	26	0.000	0.0	0	28	0.000	0.0	0
38		48	232	30	0.000	0.0	0	32	0.000	0.0	0
43		54	259	36	0.000	0.0	0	36	0.000	0.0	0
48		60	292	42	0.000	0.0	0	40	0.000	0.0	0
53		66	343	46	0.000	0.0	0	44	0.000	0.0	0
58		73	381	50	0.000	0.0	0	49	0.000	0.0	0
63		79	388	55	0.000	0.0	0	54	0.000	0.0	0
68		85	374	60	0.000	0.0	0	59	0.000	0.0	0
73		91	357	65	0.000	0.0	0	64	0.000	0.0	0
78		98	308	71	0.000	0.0	0	70	0.000	0.0	0
83		104	247	77	0.000	0.0	0	76	0.000	0.0	0
88		110	171	83	0.000	0.0	0	82	0.000	0.0	0
93		116	109	90	0.000	0.0	0	89	0.000	0.0	0
98		123	59	97	0.000	0.0	0	96	0.000	0.0	0
100 >(ACT)		125	34	100	0.000	0.0	0	100	0.000	0.0	0
	30 - (EQ)	38	285	23	0.196	7.4	2109	26	0.178	6.7	1910
	35	44	404	27	0.233	10.2	4121	30	0.201	8.8	3555
	45	56	542	39	0.328	18.5	10027	38	0.256	14.4	7805
	55	69	721	48	0.405	27.9	20116	46	0.313	21.5	15502
	65	81	768	57	0.483	39.3	30182	56	0.381	31.0	23808
	75	94	680	67	0.571	53.6	36448	66	0.452	42.4	28832
	85	106	429	79	0.674	71.6	30716	78.	0.533	56.7	24324
	95	119	177	93	0.789	93.7	16585	92	0.624	74.1	13116
	100 >(ACT)	125	37	100	0.850	106.3	3933	100	0.680	85.0	3145
							154237				121997
energy cost:		$0.024	/kWh				$3,702	/yr			$2,928 /YR
demand cost:		$152.60	/kW-yr				$25,942	/yr			$20,754 /YR
power cost:							$29,644	/yr			$23,682 /YR
installed cost:							$61,600				$82,600

OPT 2 vs OPT 1

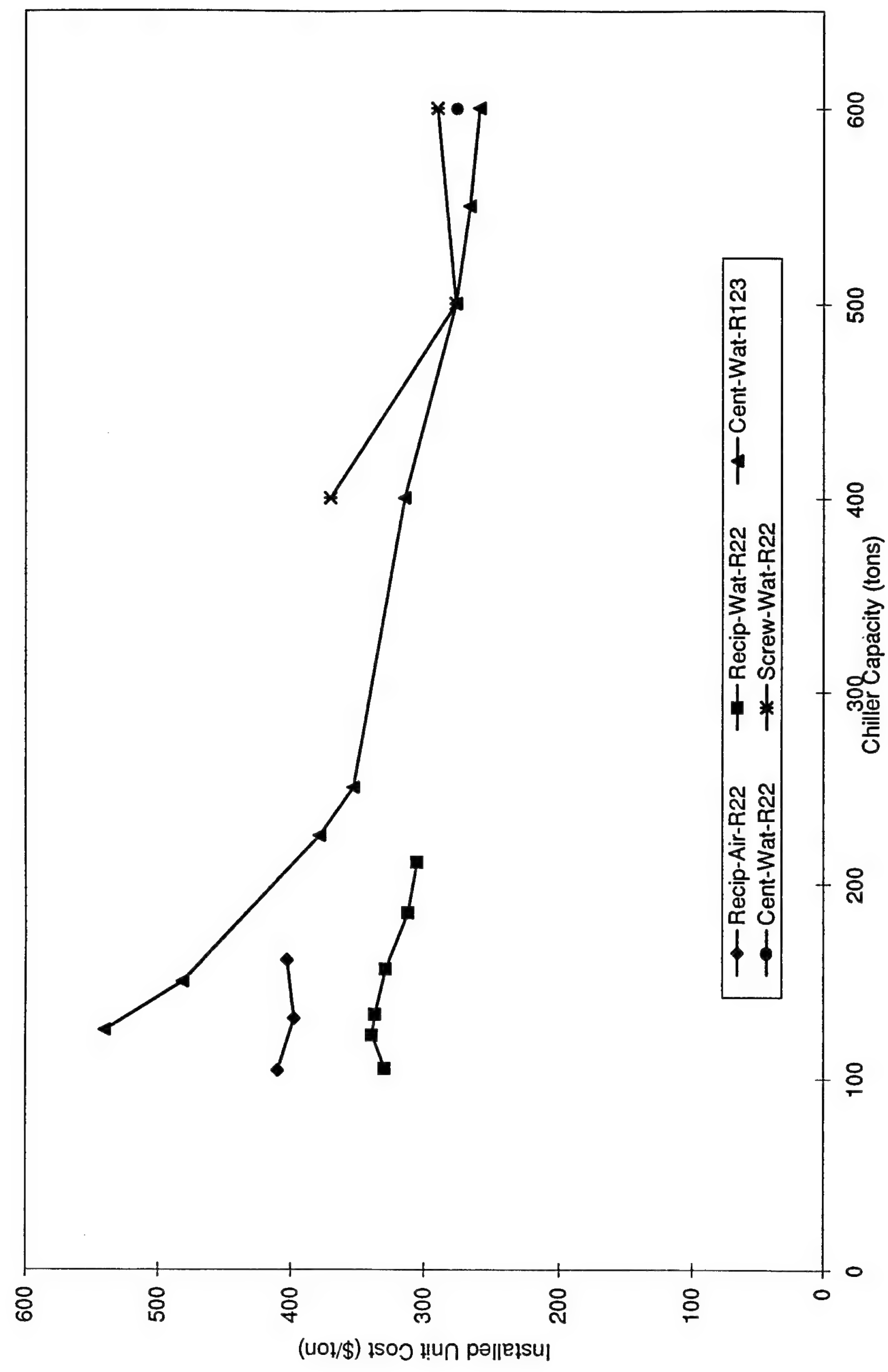
diff install cost:	$21,000	
diff power cost:	($5,962) /YR	
simple payback:	3.5 yr	(w/o Utility Rebate)

APPENDIX G

Table G-5. Comparison of Alternate Cooling Tower Types by Installed Cost and Connected Load

				WLA	MEANS	MEANS							
IN	IN	IN	IN	OUT	OUT	IN	OUT	OUT	OUT	OUT	OUT	OUT	OUT
CHILLER CAP	TOWER CAP @ 95F EWT 85F LWT 77F WB	TYPE	MODEL	MTL COST	LAB COST	EQP COST	TOT COST	UNIT MTL COST	UNIT LAB COST	UNIT EQP COST	UNIT TOT COST	TOTAL CONN LOAD	UNIT CONN LOAD
tons	MBH			$	ADJSTD $	$	$	$/ton	$/ton	$/ton	$/ton	kW	kW/ton
91.0	1365	OPEN, AXIAL	ICT-4-59	5363	619		5982	59	7	0	66	2.98	0.03
121.8	1827	OPEN, AXIAL	ICT-4-612	6444	705		7149	53	6	0	59	4.47	0.04
129.2	1938	OPEN, AXIAL	ICT-4-612	6444	726		7170	50	6	0	55	4.47	0.03
154.0	2310	OPEN, AXIAL	ICT-4-812	7467	852		8319	48	6	0	54	7.46	0.05
166.0	2490	OPEN, AXIAL	ICT-4-912	7599	916		8515	46	6	0	51	7.46	0.04
201.0	3015	OPEN, AXIAL	AT-8-59B	8960	1105		10065	45	5	0	50	7.46	0.04
240.0	3600	OPEN, AXIAL	AT-8-99B	10734	1316		12050	45	5	0	50	14.91	0.06
91.0	1365	CLOSED, AXIAL	ATW-68C	18084	619		18703	199	7	0	206	12.68	0.14
121.8	1827	CLOSED, AXIAL	ATW-91C	22779	705		23484	187	6	0	193	17.15	0.14
129.2	1938	CLOSED, AXIAL	ATW-91C	22779	726		23505	176	6	0	182	17.15	0.13
154.0	2310	CLOSED, AXIAL	ATW-135A	27993	852		28845	182	6	0	187	18.64	0.12
166.0	2490	CLOSED, AXIAL	ATW-135B	32951	916		33867	199	6	0	204	18.64	0.11
201.0	3015	CLOSED, AXIAL	ATW-135B	33396	1105		34501	166	5	0	172	26.10	0.13
240.0	3600	CLOSED, AXIAL	ATW-207A	42546	1316		43862	177	5	0	183	27.96	0.12

Figure G-1. Chiller Installed Cost vs ARI Capacity



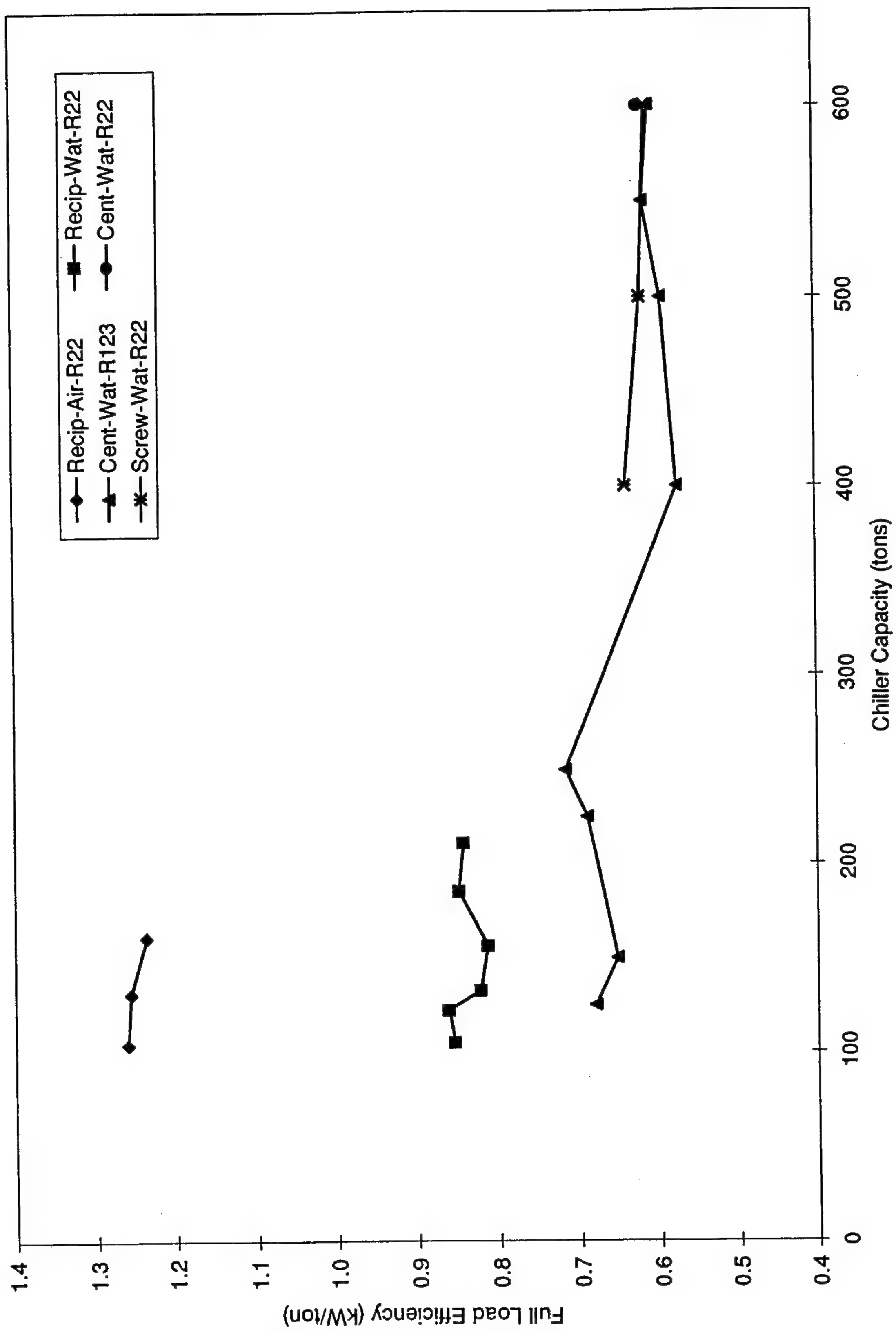
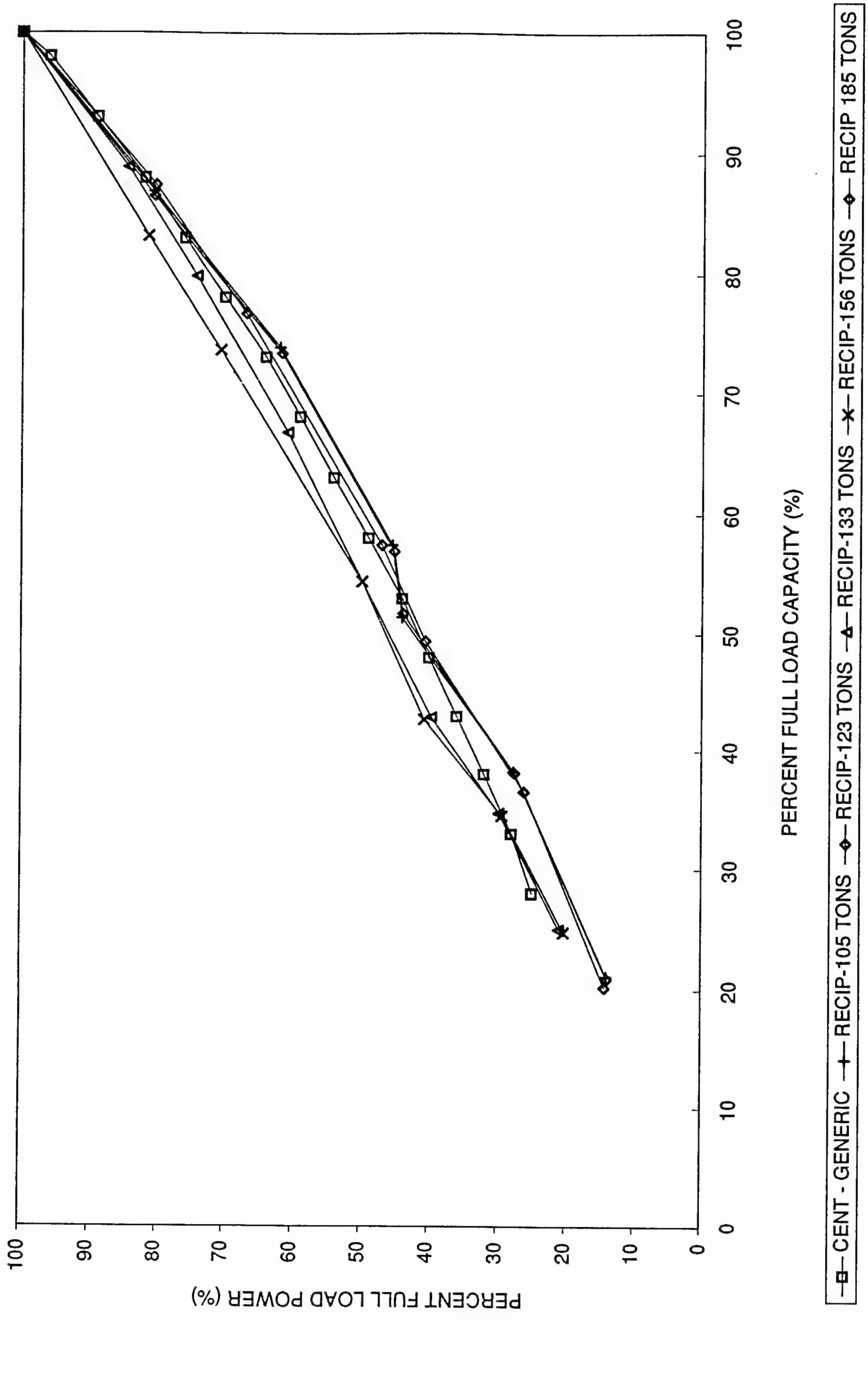


Figure G-2. Chiller Full Load Efficiency vs ARI Capacity

Figure G-3. Centrifugal & Reciprocating Water-Cooled Chiller



Appendix H: Algorithms and Data for Calculation of Chiller Energy Cost

APPENDIX H

Table H-1. Algorithyms and Data for Calculation of Chiller Energy Cost

****** PROCEDURE FOR DEVELOPING MODEL FOR TURBO-MODULATOR ******
(FACTORY SIMULATION TEMPORARILY UNAVAILABLE)

COMPARE PERFORMANCE FOR 6 MONTH COOLING SEASON

% RAT CAP	% RAT POW RECIP WAT / RECIP AIR	% RAT POW CENT WAT / SCREW WAT	% RAT POW CENT/TURBO WAT / SCREW/TURBO WAT	START w/ PUMP LAW for CAP vs BHP	ADJUST w/ LINEAR CHANGE in EFF	HRS W/O	HRS W/	KW*HR W/O	KW*HR W/
30	23	26							
35	27	30							
45	39	38							
55	48	46							
65	57	56							
75	67	66							
85	79	78							
95	93	92							
100	100	100							
13			1	0.2	0.150		104	0.0	1.0
18			3	0.6	0.190		83	0.0	2.5
23			5	1.2	0.240		106	0.0	5.3
28	21	25	8	2.2	0.280	332	143	83.0	11.4
33	26	28	11	3.6	0.330	184	184	51.5	20.2
38	30	32	15	5.5	0.370	232	232	74.2	34.8
43	36	36	19	8.0	0.420	259	259	93.2	49.2
48	42	40	24	11.1	0.460	292	292	116.8	70.1
53	46	44	29	14.9	0.510	343	343	150.9	99.5
58	50	49	35	19.5	0.550	381	381	186.7	133.4
63	55	54	42	25.0	0.600	388	388	209.5	163.0
68	60	59	49	31.4	0.640	374	374	220.7	183.3
73	65	64	56	38.9	0.690	357	357	228.5	199.9
78	71	70	65	47.5	0.730	308	308	215.6	200.2
83	77	76	73	57.2	0.780	247	247	187.7	180.3
88	83	82	83	68.1	0.820	171	171	140.2	141.9
93	90	89	92	80.4	0.870	109	109	97.0	100.3
98	97	96	103	94.1	0.910	59	59	56.6	60.8
100	100	100	108	100.0	0.930	34	34	34.0	36.7
						21	% SAVED >:	2146.1	1693.8

```
EQ-1-1    @IF(E1<S1*M1,+E1,@ROUND(S1*M1,1))

EQ-2I-1   @IF(E1*Q1<S1*M1,@ROUND(E1*Q1,1),@ROUND(S1*M1,1))
EQ-2I-2   @IF(E1*(1-Q1)<AT1*AN1,@ROUND(E1*(1-Q1),1),@ROUND(AT1*AN1,1))

EQ-2M-1   @IF(E1<Q1*M1,+E1,@IF(E1<(S1*M1)+(AT1*AN1),@ROUND(E1*M1/(M1+AN1),1),@ROUND(S1*M1,1)))
EQ-2M-2   @IF(E1-Y1<AT1*AN1,+E1-Y1,@ROUND(AT1*AN1,1))

EQ-2S-1   @IF(E1-AV1<S1*M1,+E1-AV1,@ROUND(S1*M1,1))
EQ-2S-2   @IF(E1<Q1*M1,+0,@IF(E1<(Q1*M1)+(AR1*AN1),@ROUND(AR1*AN1,1),@IF(E1<(Q1*M1)+((AR1+AT1)/2*AN1),@ROUND((AR1+AT1)/2*AN1,1),@ROUND(AT1*AN1,1))))

EQ-3-1    @IF(E1<Q1*M1,+E1,@IF(E1<Q1*(M1*AN1),@ROUND(E1*S1*M1/U1,1),@IF(E1<W1,@ROUND(E1*S1*M1/W1,1),@ROUND(S1*M1,1))))
EQ-3-2    @IF(E1<Q1*M1,+0,@IF(E1<Q1*(M1*AN1),@ROUND(E1*AT1*AN1/U1,1),@IF(E1<W1,@ROUND(E1*AT1*AN1/W1,1),@ROUND(AT1*AN1,1))))
EQ-3-3    @IF(E1-Y1-AV1<0.01,+0,@IF(E1-Y1-AV1<BO1*BK1,+E1-Y1-AV1,@ROUND(BO1*BK1,1)))
EQ-3A     (S1*M1)+(AT1*AN1)
EQ-3B     (S1*M1)+(AT1*AN1)+(BO1*BK1)
```

C	E	G	I	K	Y	AA	AC	AE	AG	AI	AK	AV	AX	AZ	BB	BD	BF	BH	BQ	BS	BU	BW	BY	CA
1 CHILLER - MODULATION					0.0	EQ-1-1																		
2 CHILLERS - INDEPENDENT MODULATION					0.0	EQ-2I-1						0.0	EQ-2I-2											
2 CHILLERS - LEAD/LAG STAGED MODULATION					0.0	EQ-2M-1						0.0	EQ-2M-2											
2 CHILLERS - LEAD MODULATION / LAG 3-STEP					0.0	EQ-2S-1						0.0	EQ-2S-2											
3 CHILLERS - LEAD/LAG STAGED MODULATION					0.0	EQ-3-1						0.0	EQ-3-2						0.0	EQ-3-3				

DEMAND CHARGE:	152.6	$/KW*YR
ENERGY CHARGE:	0.024	$/KW*HR

APPENDIX H

Table H-1. Algorithyms and Data for Calculation of Chiller Energy Cost

PLANT		
PLANT NO:	#	
BUILDING NO:	#	
DESIGN LOAD:	#	TONS
WINTER LOAD:	#	%DSGN
SIMULATION MODEL:	EQ-	
PEAK DEMAND:	0.0	KW
CONSUMPTION:	0	KWH/YR
DEMAND COST:	$0	/YR
ENERGY COST:	$0	/YR
TOTAL COST:	$0	/YR
UNIT OUTPUT COST:	#DIV/0!	/TON*YR

MASTER CHILLER NO (LEAD):	#	
COMPRESSOR:	X	W/ TURBO
CONDENSER:	X	
REFRIGERANT:	R-	
STATUS:	X	
CONFIGURATION:	X	
MAX LEAD SETPT or PRO-RATE L	#	%
LOAD LIMIT:	#	%
RATED CAPACITY:	#	TONS
RATED POWER:	#	KW
RATED EFFICIENCY:	#DIV/0!	KW/TON

MASTER CHILLER NO (LAG 1):	#	
COMPRESSOR:	X	W/ TURBO
CONDENSER:	X	
REFRIGERANT:	R-	
STATUS:	X	
CONFIGURATION:	X	
MIN LAG SETPOINT:	#	%
LOAD LIMIT:	#	%
RATED CAPACITY:	#	TONS
RATED POWER:	#	KW
RATED EFFICIENCY:	#DIV/0!	KW/TON

MASTER CHILLER NO (LAG 2):	#	
COMPRESSOR:	X	W/ TURBO
CONDENSER:	X	
REFRIGERANT:	R-	
STATUS:	X	
CONFIGURATION:	X	
LOAD LIMIT:	#	%
RATED CAPACITY:	#	TONS
RATED POWER:	#	KW
RATED EFFICIENCY:	#DIV/0!	KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND
%		TONS	TONS	HR/YR	KW
#	W	0.0	0.0	4380	0.0
	3 S	0.0	0.0	37	0.0
	8 S	0.0	0.0	50	0.0
	13 S	0.0	0.0	65	0.0
	18 S	0.0	0.0	83	0.0
	23 S	0.0	0.0	106	0.0
	28 S	0.0	0.0	143	0.0
	33 S	0.0	0.0	184	0.0
	38 S	0.0	0.0	232	0.0
	43 S	0.0	0.0	259	0.0
	48 S	0.0	0.0	292	0.0
	53 S	0.0	0.0	343	0.0
	58 S	0.0	0.0	381	0.0
	63 S	0.0	0.0	388	0.0
	68 S	0.0	0.0	374	0.0
	73 S	0.0	0.0	357	0.0
	78 S	0.0	0.0	308	0.0
	83 S	0.0	0.0	247	0.0
	88 S	0.0	0.0	171	0.0
	93 S	0.0	0.0	109	0.0
	98 S	0.0	0.0	59	0.0
	103 S	0.0	0.0	25	0.0
	108 S	0.0	0.0	7	0.0
	113 S	0.0	0.0	2	0.0
	118 S	0.0	0.0	0	0.0
				8602	

Master Chiller (Lead):

Row	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
	TONS	%	%	%	KW	HR/YR	KWH/YR
W	#	####	####	#	0.0	0	0
3 S		####	####		0.0	0	0
8 S		####	####		0.0	0	0
13 S		####	####		0.0	0	0
18 S		####	####		0.0	0	0
23 S		####	####		0.0	0	0
28 S		####	####		0.0	0	0
33 S		####	####		0.0	0	0
38 S		####	####		0.0	0	0
43 S		####	####		0.0	0	0
48 S		####	####		0.0	0	0
53 S		####	####		0.0	0	0
58 S		####	####		0.0	0	0
63 S		####	####		0.0	0	0
68 S		####	####		0.0	0	0
73 S		####	####		0.0	0	0
78 S		####	####		0.0	0	0
83 S		####	####		0.0	0	0
88 S		####	####		0.0	0	0
93 S		####	####		0.0	0	0
98 S		####	####		0.0	0	0
103 S		####	####		0.0	0	0
108 S		####	####		0.0	0	0
113 S		####	####		0.0	0	0
118 S	#	####	####	#	0.0	0	0
						0	0

Master Chiller (Lag 1):

Row	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
	TONS	%	%	%	KW	HR/YR	KWH/YR
W	#	####	####	#	0.0	0	0
3 S		####	####		0.0	0	0
8 S		####	####		0.0	0	0
13 S		####	####		0.0	0	0
18 S		####	####		0.0	0	0
23 S		####	####		0.0	0	0
28 S		####	####		0.0	0	0
33 S		####	####		0.0	0	0
38 S		####	####		0.0	0	0
43 S		####	####		0.0	0	0
48 S		####	####		0.0	0	0
53 S		####	####		0.0	0	0
58 S		####	####		0.0	0	0
63 S		####	####		0.0	0	0
68 S		####	####		0.0	0	0
73 S		####	####		0.0	0	0
78 S		####	####		0.0	0	0
83 S		####	####		0.0	0	0
88 S		####	####		0.0	0	0
93 S		####	####		0.0	0	0
98 S		####	####		0.0	0	0
103 S		####	####		0.0	0	0
108 S		####	####		0.0	0	0
113 S		####	####		0.0	0	0
118 S	#	####	####	#	0.0	0	0
						0	0

Master Chiller (Lag 2):

Row	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
	TONS	%	%	%	KW	HR/YR	KWH/YR
W	#	####	####	#	0.0	0	0
3 S		####	####		0.0	0	0
8 S		####	####		0.0	0	0
13 S		####	####		0.0	0	0
18 S		####	####		0.0	0	0
23 S		####	####		0.0	0	0
28 S		####	####		0.0	0	0
33 S		####	####		0.0	0	0
38 S		####	####		0.0	0	0
43 S		####	####		0.0	0	0
48 S		####	####		0.0	0	0
53 S		####	####		0.0	0	0
58 S		####	####		0.0	0	0
63 S		####	####		0.0	0	0
68 S		####	####		0.0	0	0
73 S		####	####		0.0	0	0
78 S		####	####		0.0	0	0
83 S		####	####		0.0	0	0
88 S		####	####		0.0	0	0
93 S		####	####		0.0	0	0
98 S		####	####		0.0	0	0
103 S		####	####		0.0	0	0
108 S		####	####		0.0	0	0
113 S		####	####		0.0	0	0
118 S	#	####	####	#	0.0	0	0
						0	0

```
          MACRO "\A" COPIES APPROPRIATE EQUATIONS TO CALCULATE CHILLER LOAD BASED UPON SPECIFIED SIMU
          START PROCESSING, AFTER "HIDING" UNNECESSARY COLUMNS, W/ CURRENT (HIGHLIGHTED) CELL ON PLA
\A        /RNCPLANTADD~~
          {DOWN 4}
          {LET EQUATION,@CELLPOINTER("CONTENTS")}~
          {RIGHT 2}{END}{RIGHT}{END}{RIGHT}{DOWN 18}
          {IF EQUATION="EQ-1"}{BRANCH EQ-1}
          {IF EQUATION="EQ-2I"}{BRANCH EQ-2I}
          {IF EQUATION="EQ-2M"}{BRANCH EQ-2M}
          {IF EQUATION="EQ-2S"}{BRANCH EQ-2S}
          {IF EQUATION="EQ-3"}{BRANCH EQ-3}
          /RNDPLANTADD~
          {BLANK EQUATION}~
          {QUIT}

EQ-1      /CEQ-1-1~.{END}{DOWN}~/RU.{END}{DOWN}~
          {GOTO}PLANTADD~
          /RNDPLANTADD~
          {BLANK EQUATION}~
          {QUIT}

EQ-2I     /CEQ-2I-1~.{END}{DOWN}~/RU.{END}{DOWN}~
          {RIGHT 15}
          /CEQ-2I-2~.{END}{DOWN}~/RU.{END}{DOWN}~
          {GOTO}PLANTADD~
          /RNDPLANTADD~
          {BLANK EQUATION}~
          {QUIT}

EQ-2M     /CEQ-2M-1~.{END}{DOWN}~/RU.{END}{DOWN}~
          {RIGHT 15}
          /CEQ-2M-2~.{END}{DOWN}~/RU.{END}{DOWN}~
          {GOTO}PLANTADD~
          /RNDPLANTADD~
          {BLANK EQUATION}~
          {QUIT}

EQ-2S     /CEQ-2S-1~.{END}{DOWN}~/RU.{END}{DOWN}~
          {RIGHT 15}
          /CEQ-2S-2~.{END}{DOWN}~/RU.{END}{DOWN}~
          {GOTO}PLANTADD~
          /RNDPLANTADD~
          {BLANK EQUATION}~
          {QUIT}

EQ-3      /CEQ-3-1~{LEFT 4}.{END}{DOWN}~/RU.{END}{DOWN}~
          {RIGHT 15}
          /CEQ-3-2~.{END}{DOWN}~/RU.{END}{DOWN}~
          {RIGHT 15}
          /CEQ-3-3~.{END}{DOWN}~/RU.{END}{DOWN}~
          {GOTO}PLANTADD~
          /RNDPLANTADD~
          {BLANK EQUATION}~
          {QUIT}

EQUATION

PLANTADD
```

```
          MACRO "\B" CALCULATES % RATED POWER FROM % RATED (ADJUSTED) CAPACITY.
          RERUN MACRO IF CHILLER CAPACITY OR LOAD IS CHANGED FOR ANY REASON.
          START PROCESSING W/ CURRENT (HIGHLIGHTED) CELL ON MASTER CHILLER NUMBER.
\B        {DOWN 2}{RIGHT 2}
          {LET TYPE,@CELLPOINTER("ADDRESS")}~
          {IF @EXACT(@@(TYPE),"W/ TURBO")}{LET OFFSET,6}~{LEFT 2}{BRANCH SET}
          {LEFT 2}
          {LET TYPE,@CELLPOINTER("ADDRESS")}~
          {IF @EXACT(@@(TYPE),"RECIP")}{LET OFFSET,2}~{BRANCH SET}
          {IF @EXACT(@@(TYPE),"CENT")}{LET OFFSET,4}~{BRANCH SET}
          {IF @EXACT(@@(TYPE),"SCREW")}{LET OFFSET,4}~{BRANCH SET}
          {BRANCH ABORT}

SET       {DOWN 20}{LEFT 6}
          {LET PASS,1}~
          {LET %FLPREV,0}~
          {BRANCH START}

START     {IF @CELLPOINTER("CONTENTS")=0}{RIGHT 2}0~{LEFT 2}{DOWN}{BRANCH START}
          {LET %FL,@CELLPOINTER("CONTENTS")}~
          {IF %FL=%FLPREV}{RIGHT 2}/C{ESC}{UP}~~{BRANCH TEST}
          {RIGHT 2}
          /RNCPOWADD~~
          {IF PASS=1}{GOTO}TABLE~{BRANCH ROUTE}
          {IF %FL<%FLPREV}{LET PASS,1}~{LET %FLPREV,0}~{GOTO}TABLE~/RNDPREVADD~{BRANCH ROUTE}
          {GOTO}PREVADD~
          /RNDPREVADD~
          {BRANCH ROUTE}

ROUTE     {IF %FL=@CELLPOINTER("CONTENTS")}{BRANCH COPY}
          {BRANCH INTER}

COPY      /RNCPREVADD~~
          {LET PASS,2}~
          {RIGHT OFFSET}
          {LET %FLPOW,@CELLPOINTER("CONTENTS")}~
          {BRANCH CONTINUE}

INTER     {IF %FL>@CELLPOINTER("CONTENTS")}{DOWN}{BRANCH INTER}
          {LET %FLHI,@CELLPOINTER("CONTENTS")}~
          {RIGHT OFFSET}
          {LET %FLPOWHI,@CELLPOINTER("CONTENTS")}~
          {UP}
          {LET %FLPOWLO,@CELLPOINTER("CONTENTS")}~
          {LEFT OFFSET}
          {LET %FLLO,@CELLPOINTER("CONTENTS")}~
          /RNCPREVADD~~
          {LET PASS,2}~
          {LET %FLPOW,@ROUND(%FLPOWLO+((%FL-%FLLO)/(%FLHI-%FLLO)*(%FLPOWHI-%FLPOWLO)),0)}~
          {BRANCH CONTINUE}

CONTINUE  {GOTO}POWADD~
          /RV%FLPOW~~
          {LET %FLPREV,%FL}~
          {BLANK VARIABLES}~
          /RNDPOWADD~
          {BRANCH TEST}

TEST      {DOWN}{LEFT 2}
          {IF @CELLPOINTER("CONTENTS")<>"b"}{BRANCH START}
          {UP}{END}{UP}{UP 20}{RIGHT 6}
          {BLANK TYPE}~
          {BLANK OFFSET}~
          {BLANK PASS}~
          {BLANK %FLPREV}~
          {BLANK %FL}
          /RNDPREVADD~
          {QUIT}~

ABORT     {BLANK TYPE}~
          {BLANK OFFSET}~
          {HOME}{GOTO}MESSAGE1~{UP}{DOWN}
          {QUIT}~

TYPE
OFFSET
PASS
%FLPREV

%FL
%FLLO
%FLHI
%FLPOWLO
%FLPOWHI
%FLPOW

POWADD
PREVADD

MESSAGE1  PROCESSING ABORTED!!!

          ENTER EITHER "RECIP", "CENT" OR "SCREW" FOR TYPE OF
          COMPRESSOR AND RESTART PROCESSING.

          ALSO, ENTER "W/ TURBO" IN SECOND CELL TO RIGHT IF CHILLER
          WILL BE EQUIPPED WITH TURBO-MODULATOR.
```

Appendix I: ECO-1 (Replace Chillers)

APPENDIX I

Table I-1. ECO-1 Calculation of Chiller Energy Cost for Existing Conditions

PLANT NO:	1		MASTER CHILLER NO (LEAD):	1	
BUILDING NO:	121				
DESIGN LOAD:	138	TONS	COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-11	
			STATUS:	EXIST	
PEAK DEMAND:	126.5	KW			
CONSUMPTION:	244094	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$19,304	/YR	LOAD LIMIT:	100	%
ENERGY COST:	$5,858	/YR			
TOTAL COST:	$25,162	/YR	RATED CAPACITY:	200.0	TONS
			RATED POWER:	171.0	KW
UNIT OUTPUT COST:	$161	/TON*YR	RATED EFFICIENCY:	0.855	KW/TON

% PLANT DSGN LOAD (%)		PLANT LOAD (TONS)	PLANT LOAD SHED (TONS)	ANNUAL OCCUR ACTUAL (HR/YR)	PLANT DEMAND (KW)	CHIL LOAD (TONS)	% RAT CAP ACT (%)	% RAT CAP ADJ (%)	% RAT POW (%)	POWER (KW)	ANNUAL OCCUR ADJUST (HR/YR)	ANNUAL ENERGY CONSUMP (KWH/YR)
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3	S	4.1	0.0	37	44.5	4.1	2	30	26	44.5	2	89
8	S	11.0	0.0	50	44.5	11.0	6	30	26	44.5	10	445
13	S	17.9	0.0	65	44.5	17.9	9	30	26	44.5	20	890
18	S	24.8	0.0	83	44.5	24.8	12	30	26	44.5	33	1469
23	S	31.7	0.0	106	44.5	31.7	16	30	26	44.5	57	2537
28	S	38.6	0.0	143	44.5	38.6	19	30	26	44.5	91	4050
33	S	45.5	0.0	184	44.5	45.5	23	30	26	44.5	141	6275
38	S	52.4	0.0	232	44.5	52.4	26	30	26	44.5	201	8945
43	S	59.3	0.0	259	44.5	59.3	30	30	26	44.5	259	11526
48	S	66.2	0.0	292	47.9	66.2	33	33	28	47.9	292	13987
53	S	73.1	0.0	343	53.0	73.1	37	37	31	53.0	343	18179
58	S	80.0	0.0	381	58.1	80.0	40	40	34	58.1	381	22136
63	S	86.9	0.0	388	61.6	86.9	43	43	36	61.6	388	23901
68	S	93.8	0.0	374	66.7	93.8	47	47	39	66.7	374	24946
73	S	100.7	0.0	357	71.8	100.7	50	50	42	71.8	357	25633
78	S	107.6	0.0	308	77.0	107.6	54	54	45	77.0	308	23716
83	S	114.5	0.0	247	82.1	114.5	57	57	48	82.1	247	20279
88	S	121.4	0.0	171	88.9	121.4	61	61	52	88.9	171	15202
93	S	128.3	0.0	109	94.1	128.3	64	64	55	94.1	109	10257
98	S	135.2	0.0	59	100.9	135.2	68	68	59	100.9	59	5953
103	S	142.1	0.0	25	106.0	142.1	71	71	62	106.0	25	2650
108	S	149.0	0.0	7	112.9	149.0	75	75	66	112.9	7	790
113	S	155.9	0.0	2	119.7	155.9	78	78	70	119.7	2	239
118	S	162.8	0.0	0	126.5	162.8	81	81	74	126.5	0	0
				8602							3877	244094

PLANT NO:	2		MASTER CHILLER NO (LEAD):	2		MASTER CHILLER NO (LAG 1):	3	
BUILDING NO:	135							
DESIGN LOAD:	91 E	TONS	COMPRESSOR:	RECIP		COMPRESSOR:	RECIP	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER		CONDENSER:	WATER	
SIMULATION MODEL:	EQ-2I		REFRIGERANT:	R-12		REFRIGERANT:	R-22	
			STATUS:	EXISTING		STATUS:	EXISTING	
PEAK DEMAND:	89.5	KW						
CONSUMPTION:	165928	KWH/YR	CONFIGURATION:	SINGLE		CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	57 E	%	MIN LAG SETPOINT:	NA	%
DEMAND COST:	$13,658	/YR	LOAD LIMIT:	100	%	LOAD LIMIT:	100	%
ENERGY COST:	$3,982	/YR						
TOTAL COST:	$17,640	/YR	RATED CAPACITY:	73.5	TONS	RATED CAPACITY:	54.9 E	TONS
			RATED POWER:	66.2 E	KW	RATED POWER:	49.4 E	KW
UNIT OUTPUT COST:	$172	/TON*YR	RATED EFFICIENCY:	0.901	KW/TON	RATED EFFICIENCY:	0.900	KW/TON

% PLANT DSGN LOAD (%)		PLANT LOAD (TONS)	PLANT LOAD SHED (TONS)	ANNUAL OCCUR ACTUAL (HR/YR)	PLANT DEMAND (KW)	CHIL LOAD (TONS)	% RAT CAP ACT (%)	% RAT CAP ADJ (%)	% RAT POW (%)	POWER (KW)	ANNUAL OCCUR ADJUST (HR/YR)	ANNUAL ENERGY CONSUMP (KWH/YR)	CHIL LOAD (TONS)	% RAT CAP ACT (%)	% RAT CAP ADJ (%)	% RAT POW (%)	POWER (KW)	ANNUAL OCCUR ADJUST (HR/YR)	ANNUAL ENERGY CONSUMP (KWH/YR)
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0	0.0	0	0	0	0.0	0	0
3	S	2.7	0.0	37	26.6	1.5	2	30	23	15.2	2	30	1.2	2	30	23	11.4	0	0
8	S	7.3	0.0	50	26.6	4.2	6	30	23	15.2	10	152	3.1	6	30	23	11.4	2	23
13	S	11.8	0.0	65	26.6	6.7	9	30	23	15.2	20	304	5.1	9	30	23	11.4	6	68
18	S	16.4	0.0	83	26.6	9.3	13	30	23	15.2	36	547	7.1	13	30	23	11.4	16	182
23	S	20.9	0.0	106	26.6	11.9	16	30	23	15.2	57	866	9.0	16	30	23	11.4	30	342
28	S	25.5	0.0	143	26.6	14.5	20	30	23	15.2	95	1444	11.0	20	30	23	11.4	63	718
33	S	30.0	0.0	184	26.6	17.1	23	30	23	15.2	141	2143	12.9	23	30	23	11.4	108	1231
38	S	34.6	0.0	232	26.6	19.7	27	30	23	15.2	209	3177	14.9	27	30	23	11.4	188	2143
43	S	39.1	0.0	259	27.1	22.3	30	30	23	15.2	259	3937	16.8	31	31	24	11.9	259	3082
48	S	43.7	0.0	292	31.2	24.9	34	34	27	17.9	292	5227	18.8	34	34	27	13.3	292	3884
53	S	48.2	0.0	343	34.0	27.5	37	37	29	19.2	343	6586	20.7	38	38	30	14.8	343	5076
58	S	52.8	0.0	381	39.3	30.1	41	41	34	22.5	381	8573	22.7	41	41	34	16.8	381	6401
63	S	57.3	0.0	388	43.3	32.7	44	44	37	24.5	388	9506	24.6	45	45	38	18.8	388	7294
68	S	61.9	0.0	374	48.5	35.3	48	48	42	27.8	374	10397	26.6	48	48	42	20.7	374	7742
73	S	66.4	0.0	357	51.3	37.8	51	51	44	29.1	357	10389	28.6	52	52	45	22.2	357	7925
78	S	71.0	0.0	308	55.5	40.5	55	55	48	31.8	308	9794	30.5	56	56	48	23.7	308	7300
83	S	75.5	0.0	247	59.0	43.0	59	59	51	33.8	247	8349	32.5	59	59	51	25.2	247	6224
88	S	80.1	0.0	171	62.9	45.7	62	62	54	35.7	171	6105	34.4	63	63	55	27.2	171	4651
93	S	84.6	0.0	109	67.1	48.2	66	66	58	38.4	109	4186	36.4	66	66	58	28.7	109	3128
98	S	89.2	0.0	59	71.0	50.8	69	69	61	40.4	59	2384	38.4	70	70	62	30.6	59	1805
103	S	93.7	0.0	25	75.1	53.4	73	73	65	43.0	25	1075	40.3	73	73	65	32.1	25	803
108	S	98.3	0.0	7	80.3	56.0	76	76	69	45.7	7	320	42.3	77	77	70	34.6	7	242
113	S	102.8	0.0	2	85.4	58.6	80	80	73	48.3	2	97	44.2	81	81	75	37.1	2	74
118	S	107.4	0.0	0	89.5	61.2	83	83	77	51.0	0	0	46.2	84	84	78	38.5	0	0
				8602							3892	95588						3735	70338

APPENDIX I

Table I-1. ECO-1 Calculation of Chiller Energy Cost for Existing Conditions

PLANT NO:	3		MASTER CHILLER NO (LEAD):		
BUILDING NO:	194				
DESIGN LOAD:	107	TONS	COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-12	
			STATUS:	EXISTING	
PEAK DEMAND:	91.5	KW			
CONSUMPTION:	195214	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$13,963	/YR	LOAD LIMIT:	100	%
ENERGY COST:	$4,685	/YR			
TOTAL COST:	$18,648	/YR	RATED CAPACITY:	228.0	TONS
			RATED POWER:	199.0	KW
UNIT OUTPUT COST:	$154	/TON*YR	RATED EFFICIENCY:	0.873	KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3	S	3.2	0.0	37	51.7	3.2	1	30	26	51.7	1	52
8	S	8.6	0.0	50	51.7	8.6	4	30	26	51.7	7	382
13	S	13.9	0.0	65	51.7	13.9	6	30	26	51.7	13	672
18	S	19.3	0.0	83	51.7	19.3	8	30	26	51.7	22	1137
23	S	24.6	0.0	106	51.7	24.6	11	30	26	51.7	39	2016
28	S	30.0	0.0	143	51.7	30.0	13	30	26	51.7	62	3205
33	S	35.3	0.0	184	51.7	35.3	15	30	26	51.7	92	4756
38	S	40.7	0.0	232	51.7	40.7	18	30	26	51.7	139	7186
43	S	46.0	0.0	259	51.7	46.0	20	30	26	51.7	173	8944
48	S	51.4	0.0	292	51.7	51.4	23	30	26	51.7	224	11581
53	S	56.7	0.0	343	51.7	56.7	25	30	26	51.7	286	14786
58	S	62.1	0.0	381	51.7	62.1	27	30	26	51.7	343	17733
63	S	67.4	0.0	388	51.7	67.4	30	30	26	51.7	388	20060
68	S	72.8	0.0	374	53.7	72.8	32	32	27	53.7	374	20084
73	S	78.1	0.0	357	57.7	78.1	34	34	29	57.7	357	20599
78	S	83.5	0.0	308	61.7	83.5	37	37	31	61.7	308	19004
83	S	88.8	0.0	247	65.7	88.8	39	39	33	65.7	247	16228
88	S	94.2	0.0	171	67.7	94.2	41	41	34	67.7	171	11577
93	S	99.5	0.0	109	73.6	99.5	44	44	37	73.6	109	8022
98	S	104.9	0.0	59	75.6	104.9	46	46	38	75.6	59	4460
103	S	110.2	0.0	25	79.6	110.2	48	48	40	79.6	25	1990
108	S	115.6	0.0	7	83.6	115.6	51	51	42	83.6	7	585
113	S	120.9	0.0	2	87.6	120.9	53	53	44	87.6	2	175
118	S	126.3	0.0	0	91.5	126.3	55	55	46	91.5	0	0
				8602							3448	195214

PLANT NO:	5		MASTER CHILLER NO (LEAD):	6		MASTER CHILLER NO (LAG 1):	7	
BUILDING NO:	410							
DESIGN LOAD:	238	TONS	COMPRESSOR:	CENT		COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER		CONDENSER:	WATER	
SIMULATION MODEL:	EQ-2M		REFRIGERANT:	R-12		REFRIGERANT:	R-12	
			STATUS:	EXISTING		STATUS:	EXISTING	
PEAK DEMAND:	158.0	KW						
CONSUMPTION:	371264	KWH/YR	CONFIGURATION:	PARALLEL		CONFIGURATION:	PARALLEL	
			MAX LEAD SETPT or PRO-RATE LOAD:	80	%	MIN LAG SETPOINT:	NA	%
DEMAND COST:	$24,111	/YR	LOAD LIMIT:	100	%	LOAD LIMIT:	100	%
ENERGY COST:	$8,910	/YR						
TOTAL COST:	$33,021	/YR	RATED CAPACITY:	110.0	TONS	RATED CAPACITY:	110.0	TONS
			RATED POWER:	79.0	KW	RATED POWER:	79.0	KW
UNIT OUTPUT COST:	$150	/TON*YR	RATED EFFICIENCY:	0.718	KW/TON	RATED EFFICIENCY:	0.718	KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR	TONS	%	%	%	KW	HR/YR	KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0	0.0	0	0	0	0.0	0	0
3	S	7.1	0.0	37	20.5	7.1	6	30	26	20.5	7	144	0.0	0	0	0	0.0	0	0
8	S	19.0	0.0	50	20.5	19.0	17	30	26	20.5	28	574	0.0	0	0	0	0.0	0	0
13	S	30.9	0.0	65	20.5	30.9	28	30	26	20.5	61	1251	0.0	0	0	0	0.0	0	0
18	S	42.8	0.0	83	26.1	42.8	39	39	33	26.1	83	2166	0.0	0	0	0	0.0	0	0
23	S	54.7	0.0	106	33.2	54.7	50	50	42	33.2	106	3519	0.0	0	0	0	0.0	0	0
28	S	66.6	0.0	143	41.1	66.6	61	61	52	41.1	143	5877	0.0	0	0	0	0.0	0	0
33	S	78.5	0.0	184	49.0	78.5	71	71	62	49.0	184	9016	0.0	0	0	0	0.0	0	0
38	S	90.4	0.0	232	53.8	45.2	41	41	34	26.9	232	6241	45.2	41	41	34	26.9	232	6241
43	S	102.3	0.0	259	60.8	51.2	47	47	39	30.8	259	7977	51.1	46	46	38	30.0	259	7770
48	S	114.2	0.0	292	68.0	57.1	52	52	43	34.0	292	9928	57.1	52	52	43	34.0	292	9928
53	S	126.1	0.0	343	75.8	63.1	57	57	48	37.9	343	13000	63.0	57	57	48	37.9	343	13000
58	S	138.0	0.0	381	85.4	69.0	63	63	54	42.7	381	16269	69.0	63	63	54	42.7	381	16269
63	S	149.9	0.0	388	93.2	75.0	68	68	59	46.6	388	18081	74.9	68	68	59	46.6	388	18081
68	S	161.8	0.0	374	102.8	80.9	74	74	65	51.4	374	19224	80.9	74	74	65	51.4	374	19224
73	S	173.7	0.0	357	112.2	86.9	79	79	71	56.1	357	20028	86.8	79	79	71	56.1	357	20028
78	S	185.6	0.0	308	121.6	92.8	84	84	77	60.8	308	18726	92.8	84	84	77	60.8	308	18726
83	S	197.5	0.0	247	134.4	98.8	90	90	85	67.2	247	16598	98.7	90	90	85	67.2	247	16598
88	S	209.4	0.0	171	145.4	104.7	95	95	92	72.7	171	12432	104.7	95	95	92	72.7	171	12432
93	S	221.3	1.3	109	158.0	110.0	100	100	100	79.0	109	8611	110.0	100	100	100	79.0	109	8611
98	S	233.2	13.2	59	158.0	110.0	100	100	100	79.0	59	4661	110.0	100	100	100	79.0	59	4661
103	S	245.1	25.1	25	158.0	110.0	100	100	100	79.0	25	1975	110.0	100	100	100	79.0	25	1975
108	S	257.0	37.0	7	158.0	110.0	100	100	100	79.0	7	553	110.0	100	100	100	79.0	7	553
113	S	268.9	48.9	2	158.0	110.0	100	100	100	79.0	2	158	110.0	100	100	100	79.0	2	158
118	S	280.8	60.8	0	158.0	110.0	100	100	100	79.0	0	0	110.0	100	100	100	79.0	0	0
				8602							4166	197009						3554	174255

APPENDIX I

Table I-1. ECO-1 Calculation of Chiller Energy Cost for Existing Conditions

PLANT NO:	6		MASTER CHILLER NO (LEAD):	8	
BUILDING NO:	2805				
DESIGN LOAD:	116	TONS	COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-113	
			STATUS:	EXIST	
PEAK DEMAND:	115.9	KW			
CONSUMPTION:	216891	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$17,686	/YR	LOAD LIMIT:	100	%
ENERGY COST:	$5,205	/YR			
TOTAL COST:	$22,892	/YR	RATED CAPACITY:	149.8	TONS
			RATED POWER:	134.8 E	KW
UNIT OUTPUT COST:	$175	/TON*YR	RATED EFFICIENCY:	0.900	KW/TON

% PLANT DSGN LOAD %		PLANT LOAD TONS	PLANT LOAD SHED TONS	ANNUAL OCCUR ACTUAL HR/YR	PLANT DEMAND KW	CHIL LOAD TONS	% RAT CAP ACT %	% RAT CAP ADJ %	% RAT POW %	POWER KW	ANNUAL OCCUR ADJUST HR/YR	ANNUAL ENERGY CONSUMP KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3	S	3.5	0.0	37	35.0	3.5	2	30	26	35.0	2	70
8	S	9.3	0.0	50	35.0	9.3	6	30	26	35.0	10	350
13	S	15.1	0.0	65	35.0	15.1	10	30	26	35.0	22	770
18	S	20.9	0.0	83	35.0	20.9	14	30	26	35.0	39	1365
23	S	26.7	0.0	106	35.0	26.7	18	30	26	35.0	64	2240
28	S	32.5	0.0	143	35.0	32.5	22	30	26	35.0	105	3675
33	S	38.3	0.0	184	35.0	38.3	26	30	26	35.0	159	5565
38	S	44.1	0.0	232	35.0	44.1	29	30	26	35.0	224	7840
43	S	49.9	0.0	259	37.7	49.9	33	33	28	37.7	259	9764
48	S	55.7	0.0	292	41.8	55.7	37	37	31	41.8	292	12206
53	S	61.5	0.0	343	45.8	61.5	41	41	34	45.8	343	15709
58	S	67.3	0.0	381	51.2	67.3	45	45	38	51.2	381	19507
63	S	73.1	0.0	388	55.3	73.1	49	49	41	55.3	388	21456
68	S	78.9	0.0	374	59.3	78.9	53	53	44	59.3	374	22178
73	S	84.7	0.0	357	64.7	84.7	57	57	48	64.7	357	23098
78	S	90.5	0.0	308	68.7	90.5	60	60	51	68.7	308	21160
83	S	96.3	0.0	247	74.1	96.3	64	64	55	74.1	247	18303
88	S	102.1	0.0	171	79.5	102.1	68	68	59	79.5	171	13595
93	S	107.9	0.0	109	84.9	107.9	72	72	63	84.9	109	9254
98	S	113.7	0.0	59	91.7	113.7	76	76	68	91.7	59	5410
103	S	119.5	0.0	25	97.1	119.5	80	80	72	97.1	25	2428
108	S	125.3	0.0	7	103.8	125.3	84	84	77	103.8	7	727
113	S	131.1	0.0	2	110.5	131.1	88	88	82	110.5	2	221
118	S	136.9	0.0	0	115.9	136.9	91	91	86	115.9	0	0
				8602							3947	216891

PLANT NO:	7		MASTER CHILLER NO (LEAD):			MASTER CHILLER NO (LAG 1):	10	
BUILDING NO:	5764							
DESIGN LOAD:	210 E	TONS	COMPRESSOR:	CENT		COMPRESSOR:	RECIP	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER		CONDENSER:	AIR	
SIMULATION MODEL:	EQ-2M		REFRIGERANT:	R-113		REFRIGERANT:	R-22	
			STATUS:	EXISTING		STATUS:	EXISTING	
PEAK DEMAND:	227.9	KW						
CONSUMPTION:	406474	KWH/YR	CONFIGURATION:	PARALLEL		CONFIGURATION:	PARALLEL	
			MAX LEAD SETPT or PRO-RATE LOAD:	80	%	MIN LAG SETPOINT:	NA	%
DEMAND COST:	$34,778	/YR	LOAD LIMIT:	100	%	LOAD LIMIT:	100	%
ENERGY COST:	$9,755	/YR						
TOTAL COST:	$44,533	/YR	RATED CAPACITY:	178.0	TONS	RATED CAPACITY:	71.6	TONS
			RATED POWER:	160.2 E	KW	RATED POWER:	71.6 E	KW
UNIT OUTPUT COST:	$188	/TON*YR	RATED EFFICIENCY:	0.900	KW/TON	RATED EFFICIENCY:	1.000	KW/TON

% PLANT DSGN LOAD %		PLANT LOAD. TONS	PLANT LOAD SHED TONS	ANNUAL OCCUR ACTUAL HR/YR	PLANT DEMAND KW	CHIL LOAD TONS	% RAT CAP ACT %	% RAT CAP ADJ %	% RAT POW %	POWER KW	ANNUAL OCCUR ADJUST HR/YR	ANNUAL ENERGY CONSUMP KWH/YR	CHIL LOAD TONS	% RAT CAP ACT %	% RAT CAP ADJ %	% RAT POW %	POWER KW	ANNUAL OCCUR ADJUST HR/YR	ANNUAL ENERGY CONSUMP KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0	0.0	0	0	0	0.0	0	0
3	S	6.3	0.0	37	41.7	6.3	4	30	26	41.7	5	209	0.0	0	0	0	0.0	0	0
8	S	16.8	0.0	50	41.7	16.8	9	30	26	41.7	15	626	0.0	0	0	0	0.0	0	0
13	S	27.3	0.0	65	41.7	27.3	15	30	26	41.7	33	1376	0.0	0	0	0	0.0	0	0
18	S	37.8	0.0	83	41.7	37.8	21	30	26	41.7	58	2419	0.0	0	0	0	0.0	0	0
23	S	48.3	0.0	106	41.7	48.3	27	30	26	41.7	95	3962	0.0	0	0	0	0.0	0	0
28	S	58.8	0.0	143	44.9	58.8	33	33	28	44.9	143	6421	0.0	0	0	0	0.0	0	0
33	S	69.3	0.0	184	52.9	69.3	39	39	33	52.9	184	9734	0.0	0	0	0	0.0	0	0
38	S	79.8	0.0	232	60.9	79.8	45	45	38	60.9	232	14129	0.0	0	0	0	0.0	0	0
43	S	90.3	0.0	259	67.3	90.3	51	51	42	67.3	259	17431	0.0	0	0	0	0.0	0	0
48	S	100.8	0.0	292	76.9	100.8	57	57	48	76.9	292	22455	0.0	0	0	0	0.0	0	0
53	S	111.3	0.0	343	86.5	111.3	63	63	54	86.5	343	29670	0.0	0	0	0	0.0	0	0
58	S	121.8	0.0	381	94.5	121.8	68	68	59	94.5	381	36005	0.0	0	0	0	0.0	0	0
63	S	132.3	0.0	388	104.1	132.3	74	74	65	104.1	388	40391	0.0	0	0	0	0.0	0	0
68	S	142.8	0.0	374	112.0	101.8	57	57	48	76.9	374	28761	41.0	57	57	49	35.1	374	13127
73	S	153.3	0.0	357	121.2	109.3	61	61	52	83.3	357	29738	44.0	61	61	53	37.9	357	13530
78	S	163.8	0.0	308	132.8	116.8	66	66	57	91.3	308	28120	47.0	66	66	58	41.5	308	12782
83	S	174.3	0.0	247	142.1	124.3	70	70	61	97.7	247	24132	50.0	70	70	62	44.4	247	10967
88	S	184.8	0.0	171	151.4	131.8	74	74	65	104.1	171	17801	53.0	74	74	66	47.3	171	8088
93	S	195.3	0.0	109	162.9	139.3	78	78	70	112.1	109	12219	56.0	78	78	71	50.8	109	5537
98	S	205.8	0.0	59	174.6	146.8	82	82	75	120.2	59	7092	59.0	82	82	76	54.4	59	3210
103	S	216.3	0.0	25	188.5	154.3	87	87	81	129.8	25	3245	62.0	87	87	82	58.7	25	1468
108	S	226.8	0.0	7	200.1	161.7	91	91	86	137.8	7	965	65.1	91	91	87	62.3	7	436
113	S	237.3	0.0	2	214.0	169.2	95	95	92	147.4	2	295	68.1	95	95	93	66.6	2	133
118	S	247.8	0.0	0	227.9	176.7	99	99	98	157.0	0	0	71.1	99	99	99	70.9	0	0
				8602							4087	337196						1659	69278

APPENDIX I

Table I-1. ECO-1 Calculation of Chiller Energy Cost for Existing Conditions

PLANT NO:	8		MASTER CHILLER NO (LEAD):	11
BUILDING NO:	5792			
DESIGN LOAD:	176	TONS	COMPRESSOR:	CENT
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-113
			STATUS:	EXISTING
PEAK DEMAND:	157.0	KW		
CONSUMPTION:	351948	KWH/YR	CONFIGURATION:	SINGLE
			MAX LEAD SETPT or PRO-RATE LOAD:	NA %
DEMAND COST:	$23,958	/YR	LOAD LIMIT:	100 %
ENERGY COST:	$8,447	/YR		
TOTAL COST:	$32,405	/YR	RATED CAPACITY:	170.0 TONS
			RATED POWER:	157.0 KW
UNIT OUTPUT COST:	$191	/TON*YR	RATED EFFICIENCY:	0.924 KW/TON

% PLANT DSGN LOAD (%)		PLANT LOAD (TONS)	PLANT LOAD SHED (TONS)	ANNUAL OCCUR ACTUAL (HR/YR)	PLANT DEMAND (KW)	CHIL LOAD (TONS)	% RAT CAP ACT (%)	% RAT CAP ADJ (%)	% RAT POW (%)	POWER (KW)	ANNUAL OCCUR ADJUST (HR/YR)	ANNUAL ENERGY CONSUMP (KWH/YR)
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3	S	5.3	0.0	37	40.8	5.3	3	30	26	40.8	4	163
8	S	14.1	0.0	50	40.8	14.1	8	30	26	40.8	13	530
13	S	22.9	0.0	65	40.8	22.9	13	30	26	40.8	28	1142
18	S	31.7	0.0	83	40.8	31.7	19	30	26	40.8	53	2162
23	S	40.5	0.0	106	40.8	40.5	24	30	26	40.8	85	3468
28	S	49.3	0.0	143	40.8	49.3	29	30	26	40.8	138	5630
33	S	58.1	0.0	184	45.5	58.1	34	34	29	45.5	184	8372
38	S	66.9	0.0	232	51.8	66.9	39	39	33	51.8	232	12018
43	S	75.7	0.0	259	59.7	75.7	45	45	38	59.7	259	15462
48	S	84.5	0.0	292	65.9	84.5	50	50	42	65.9	292	19243
53	S	93.3	0.0	343	72.2	93.3	55	55	46	72.2	343	24765
58	S	102.1	0.0	381	80.1	102.1	60	60	51	80.1	381	30518
63	S	110.9	0.0	388	87.9	110.9	65	65	56	87.9	388	34105
68	S	119.7	0.0	374	95.8	119.7	70	70	61	95.8	374	35829
73	S	128.5	0.0	357	106.8	128.5	76	76	68	106.8	357	38128
78	S	137.3	0.0	308	116.2	137.3	81	81	74	116.2	308	35790
83	S	146.1	0.0	247	125.6	146.1	86	86	80	125.6	247	31023
88	S	154.9	0.0	171	135.0	154.9	91	91	86	135.0	171	23085
93	S	163.7	0.0	109	146.0	163.7	96	96	93	146.0	109	15914
98	S	172.5	2.5	59	157.0	170.0	100	100	100	157.0	59	9263
103	S	181.3	11.3	25	157.0	170.0	100	100	100	157.0	25	3925
108	S	190.1	20.1	7	157.0	170.0	100	100	100	157.0	7	1099
113	S	198.9	28.9	2	157.0	170.0	100	100	100	157.0	2	314
118	S	207.7	37.7	0	157.0	170.0	100	100	100	157.0	0	0
				8602							4059	351948

PLANT NO:	9		MASTER CHILLER NO (LEAD):	12	MASTER CHILLER NO (LAG 1):	13
BUILDING NO:	7050					
DESIGN LOAD:	306	TONS	COMPRESSOR:	CENT	COMPRESSOR:	CENT
WINTER LOAD:	15	%DSGN	CONDENSER:	WATER	CONDENSER:	WATER
SIMULATION MODEL:	EQ-2M		REFRIGERANT:	R-12	REFRIGERANT:	R-12
			STATUS:	EXISTING	STATUS:	EXISTING
PEAK DEMAND:	308.8	KW				
CONSUMPTION:	744803	KWH/YR	CONFIGURATION:	PARALLEL	CONFIGURATION:	PARALLEL
			MAX LEAD SETPT or PRO-RATE LOAD:	80 %	MIN LAG SETPOINT:	NA %
DEMAND COST:	$47,123	/YR	LOAD LIMIT:	100 %	LOAD LIMIT:	100 %
ENERGY COST:	$17,875	/YR				
TOTAL COST:	$64,998	/YR	RATED CAPACITY:	210.0 TONS	RATED CAPACITY:	210.0 TONS
			RATED POWER:	193.0 KW	RATED POWER:	193.0 KW
UNIT OUTPUT COST:	$188	/TON*YR	RATED EFFICIENCY:	0.919 KW/TON	RATED EFFICIENCY:	0.919 KW/TON

% PLANT DSGN LOAD (%)		PLANT LOAD (TONS)	PLANT LOAD SHED (TONS)	ANNUAL OCCUR ACTUAL (HR/YR)	PLANT DEMAND (KW)	CHIL LOAD (TONS)	% RAT CAP ACT (%)	% RAT CAP ADJ (%)	% RAT POW (%)	POWER (KW)	ANNUAL OCCUR ADJUST (HR/YR)	ANNUAL ENERGY CONSUMP (KWH/YR)	CHIL LOAD (TONS)	% RAT CAP ACT (%)	% RAT CAP ADJ (%)	% RAT POW (%)	POWER (KW)	ANNUAL OCCUR ADJUST (HR/YR)	ANNUAL ENERGY CONSUMP (KWH/YR)
15	W	45.9	0.0	4380	50.2	45.9	22	30	26	50.2	3212	161242	0.0	0	0	0	0.0	0	0
3	S	9.2	0.0	37	50.2	9.2	4	30	26	50.2	5	251	0.0	0	0	0	0.0	0	0
8	S	24.5	0.0	50	50.2	24.5	12	30	26	50.2	20	1004	0.0	0	0	0	0.0	0	0
13	S	39.8	0.0	65	50.2	39.8	19	30	26	50.2	41	2058	0.0	0	0	0	0.0	0	0
18	S	55.1	0.0	83	50.2	55.1	26	30	26	50.2	72	3614	0.0	0	0	0	0.0	0	0
23	S	70.4	0.0	106	56.0	70.4	34	34	29	56.0	106	5936	0.0	0	0	0	0.0	0	0
28	S	85.7	0.0	143	65.6	85.7	41	41	34	65.6	143	9381	0.0	0	0	0	0.0	0	0
33	S	101.0	0.0	184	77.2	101.0	48	48	40	77.2	184	14205	0.0	0	0	0	0.0	0	0
38	S	116.3	0.0	232	88.8	116.3	55	55	46	88.8	232	20602	0.0	0	0	0	0.0	0	0
43	S	131.6	0.0	259	104.2	131.6	63	63	54	104.2	259	26988	0.0	0	0	0	0.0	0	0
48	S	146.9	0.0	292	117.7	146.9	70	70	61	117.7	292	34388	0.0	0	0	0	0.0	0	0
53	S	162.2	0.0	343	133.2	162.2	77	77	69	133.2	343	45688	0.0	0	0	0	0.0	0	0
58	S	177.5	0.0	381	135.2	88.8	42	42	35	67.6	381	25756	88.7	42	42	35	67.6	381	25756
63	S	192.8	0.0	388	146.6	98.4	46	46	38	73.3	388	28440	98.4	46	46	38	73.3	388	28440
68	S	208.1	0.0	374	162.2	104.1	50	50	42	81.1	374	30331	104.0	50	50	42	81.1	374	30331
73	S	223.4	0.0	357	169.8	111.7	53	53	44	84.9	357	30309	111.7	53	53	44	84.9	357	30309
78	S	238.7	0.0	308	185.2	119.4	57	57	48	92.6	308	28521	119.3	57	57	48	92.6	308	28521
83	S	254.0	0.0	247	196.8	127.0	60	60	51	98.4	247	24305	127.0	60	60	51	98.4	247	24305
88	S	269.3	0.0	171	212.4	134.7	64	64	55	106.2	171	18160	134.6	64	64	55	106.2	171	18160
93	S	284.6	0.0	109	227.8	142.3	68	68	59	113.9	109	12415	142.3	68	68	59	113.9	109	12415
98	S	299.9	0.0	59	239.4	150.0	71	71	62	119.7	59	7062	149.9	71	71	62	119.7	59	7062
103	S	315.2	0.0	25	254.8	157.6	75	75	66	127.4	25	3185	157.6	75	75	66	127.4	25	3185
108	S	330.5	0.0	7	274.0	165.3	79	79	71	137.0	7	959	165.2	79	79	71	137.0	7	959
113	S	345.8	0.0	2	289.6	172.9	82	82	75	144.8	2	290	172.9	82	82	75	144.8	2	290
118	S	361.1	0.0	0	308.8	180.6	86	86	80	154.4	0	0	180.5	86	86	80	154.4	0	0
				8602							7337	535070						2428	209733

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Table I-1. ECO-1 Calculation of Chiller Energy Cost for Existing Conditions

PLANT NO:	10		MASTER CHILLER NO (LEAD):	14		MASTER CHILLER NO (LAG 1):	15	
BUILDING NO:	7051							
DESIGN LOAD:	158	TONS	COMPRESSOR:	CENT		COMPRESSOR:	CENT	
WINTER LOAD:	15	%DSGN	CONDENSER:	WATER		CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-11		REFRIGERANT:	R-11	
			STATUS:	EXISTING		STATUS:	EXISTING	
PEAK DEMAND:	121.0	KW						
CONSUMPTION:	303324	KWH/YR	CONFIGURATION:	SERIES/ACTIVE		CONFIGURATION:	SERIES/REDUND	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%	MIN LAG SETPOINT:	NA	%
DEMAND COST:	$18,465	/YR	LOAD LIMIT:	100	%	LOAD LIMIT:	100	%
ENERGY COST:	$7,280	/YR						
TOTAL COST:	$25,744	/YR	RATED CAPACITY:	170.0	TONS	RATED CAPACITY:	170.0	TONS
			RATED POWER:	121.0	KW	RATED POWER:	121.0	KW
UNIT OUTPUT COST:	$151	/TON*YR	RATED EFFICIENCY:	0.712	KW/TON	RATED EFFICIENCY:	0.712	KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP	CHL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR	TONS	%	%	%	KW	HR/YR	KWH/YR
15	W	23.7	0.0	4380	31.5	23.7	14	30	26	31.5	2044	64386	#	0	0	#	0.0	0	0
3	S	4.7	0.0	37	31.5	4.7	3	30	26	31.5	4	126		0	0		0.0	0	0
8	S	12.6	0.0	50	31.5	12.6	7	30	26	31.5	12	378		0	0		0.0	0	0
13	S	20.5	0.0	65	31.5	20.5	12	30	26	31.5	26	819		0	0		0.0	0	0
18	S	28.4	0.0	83	31.5	28.4	17	30	26	31.5	47	1481		0	0		0.0	0	0
23	S	36.3	0.0	106	31.5	36.3	21	30	26	31.5	74	2331		0	0		0.0	0	0
28	S	44.2	0.0	143	31.5	44.2	26	30	26	31.5	124	3906		0	0		0.0	0	0
33	S	52.1	0.0	184	32.7	52.1	31	31	27	32.7	184	6017		0	0		0.0	0	0
38	S	60.0	0.0	232	36.3	60.0	35	35	30	36.3	232	8422		0	0		0.0	0	0
43	S	67.9	0.0	259	41.1	67.9	40	40	34	41.1	259	10645		0	0		0.0	0	0
48	S	75.8	0.0	292	46.0	75.8	45	45	38	46.0	292	13432		0	0		0.0	0	0
53	S	83.7	0.0	343	49.6	83.7	49	49	41	49.6	343	17013		0	0		0.0	0	0
58	S	91.6	0.0	381	54.5	91.6	54	54	45	54.5	381	20765		0	0		0.0	0	0
63	S	99.5	0.0	388	60.5	99.5	59	59	50	60.5	388	23474		0	0		0.0	0	0
68	S	107.4	0.0	374	65.3	107.4	63	63	54	65.3	374	24422		0	0		0.0	0	0
73	S	115.3	0.0	357	71.4	115.3	68	68	59	71.4	357	25490		0	0		0.0	0	0
78	S	123.2	0.0	308	76.2	123.2	72	72	63	76.2	308	23470		0	0		0.0	0	0
83	S	131.1	0.0	247	83.5	131.1	77	77	69	83.5	247	20625		0	0		0.0	0	0
88	S	139.0	0.0	171	90.8	139.0	82	82	75	90.8	171	15527		0	0		0.0	0	0
93	S	146.9	0.0	109	96.8	146.9	86	86	80	96.8	109	10551		0	0		0.0	0	0
98	S	154.8	0.0	59	104.1	154.8	91	91	86	104.1	59	6142		0	0		0.0	0	0
103	S	162.7	0.0	25	112.5	162.7	96	96	93	112.5	25	2813		0	0		0.0	0	0
108	S	170.6	0.6	7	121.0	170.0	100	100	100	121.0	7	847		0	0		0.0	0	0
113	S	178.5	8.5	2	121.0	170.0	100	100	100	121.0	2	242		0	0		0.0	0	0
118	S	186.4	16.4	0	121.0	170.0	100	100	100	121.0	0	0	#	0	0	#	0.0	0	0
				8602							6069	303324						0	0

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Table I-1. ECO-1 Calculation of Chiller Energy Cost for Existing Conditions

PLANT NO:	13		MASTER CHILLER NO (LEAD):	20	
BUILDING NO:	14020				
DESIGN LOAD:	154	TONS	COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-113	
			STATUS:	EXISTING	
PEAK DEMAND:	119.4	KW			
CONSUMPTION:	288530	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$18,220	/YR	LOAD LIMIT:	100	%
ENERGY COST:	$6,925	/YR			
TOTAL COST:	$25,145	/YR	RATED CAPACITY:	140.4	TONS
			RATED POWER:	119.4	KW
UNIT OUTPUT COST:	$179	/TON*YR	RATED EFFICIENCY:	0.850	KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3	S	4.6	0.0	37	31.0	4.6	3	15	26	31.0	7	217
8	S	12.3	0.0	50	31.0	12.3	9	15	26	31.0	30	930
13	S	20.0	0.0	65	31.0	20.0	14	15	26	31.0	61	1891
18	S	27.7	0.0	83	31.0	27.7	20	20	26	31.0	83	2573
23	S	35.4	0.0	106	31.0	35.4	25	25	26	31.0	106	3286
28	S	43.1	0.0	143	32.2	43.1	31	31	27	32.2	143	4605
33	S	50.8	0.0	184	35.8	50.8	36	36	30	35.8	184	6587
38	S	58.5	0.0	232	41.8	58.5	42	42	35	41.8	232	9698
43	S	66.2	0.0	259	46.6	66.2	47	47	39	46.6	259	12069
48	S	73.9	0.0	292	52.5	73.9	53	53	44	52.5	292	15330
53	S	81.6	0.0	343	58.5	81.6	58	58	49	58.5	343	20066
58	S	89.3	0.0	381	65.7	89.3	64	64	55	65.7	381	25032
63	S	97.0	0.0	388	71.6	97.0	69	69	60	71.6	388	27781
68	S	104.7	0.0	374	78.8	104.7	75	75	66	78.8	374	29471
73	S	112.4	0.0	357	86.0	112.4	80	80	72	86.0	357	30702
78	S	120.1	0.0	308	95.5	120.1	86	86	80	95.5	308	29414
83	S	127.8	0.0	247	102.7	127.8	91	91	86	102.7	247	25367
88	S	135.5	0.0	171	113.4	135.5	97	97	95	113.4	171	19391
93	S	143.2	2.8	109	119.4	140.4	100	100	100	119.4	109	13015
98	S	150.9	10.5	59	119.4	140.4	100	100	100	119.4	59	7045
103	S	158.6	18.2	25	119.4	140.4	100	100	100	119.4	25	2985
108	S	166.3	25.9	7	119.4	140.4	100	100	100	119.4	7	836
113	S	174.0	33.6	2	119.4	140.4	100	100	100	119.4	2	239
118	S	181.7	41.3	0	119.4	140.4	100	100	100	119.4	0	0
				8602							4168	288530

PLANT NO:	14		MASTER CHILLER NO (LEAD):	21	
BUILDING NO:	14023				
DESIGN LOAD:	166	TONS	COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-113	
			STATUS:	EXISTING	
PEAK DEMAND:	124.2	KW			
CONSUMPTION:	312200	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$18,953	/YR	LOAD LIMIT:	100	%
ENERGY COST:	$7,493	/YR			
TOTAL COST:	$26,446	/YR	RATED CAPACITY:	146.0	TONS
			RATED POWER:	124.2	KW
UNIT OUTPUT COST:	$181	/TON*YR	RATED EFFICIENCY:	0.851	KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3	S	5.0	0.0	37	32.3	5.0	3	15	26	32.3	7	226
8	S	13.3	0.0	50	32.3	13.3	9	15	26	32.3	30	969
13	S	21.6	0.0	65	32.3	21.6	15	15	26	32.3	65	2100
18	S	29.9	0.0	83	32.3	29.9	20	20	26	32.3	83	2681
23	S	38.2	0.0	106	32.3	38.2	26	26	26	32.3	106	3424
28	S	46.5	0.0	143	33.5	46.5	32	32	27	33.5	143	4791
33	S	54.8	0.0	184	39.7	54.8	38	38	32	39.7	184	7305
38	S	63.1	0.0	232	44.7	63.1	43	43	36	44.7	232	10370
43	S	71.4	0.0	259	50.9	71.4	49	49	41	50.9	259	13183
48	S	79.7	0.0	292	57.1	79.7	55	55	46	57.1	292	16673
53	S	88.0	0.0	343	63.3	88.0	60	60	51	63.3	343	21712
58	S	96.3	0.0	381	70.8	96.3	66	66	57	70.8	381	26975
63	S	104.6	0.0	388	78.2	104.6	72	72	63	78.2	388	30342
68	S	112.9	0.0	374	85.7	112.9	77	77	69	85.7	374	32052
73	S	121.2	0.0	357	94.4	121.2	83	83	76	94.4	357	33701
78	S	129.5	0.0	308	103.1	129.5	89	89	83	103.1	308	31755
83	S	137.8	0.0	247	111.8	137.8	94	94	90	111.8	247	27615
88	S	146.1	0.1	171	124.2	146.0	100	100	100	124.2	171	21238
93	S	154.4	8.4	109	124.2	146.0	100	100	100	124.2	109	13538
98	S	162.7	16.7	59	124.2	146.0	100	100	100	124.2	59	7328
103	S	171.0	25.0	25	124.2	146.0	100	100	100	124.2	25	3105
108	S	179.3	33.3	7	124.2	146.0	100	100	100	124.2	7	869
113	S	187.6	41.6	2	124.2	146.0	100	100	100	124.2	2	248
118	S	195.9	49.9	0	124.2	146.0	100	100	100	124.2	0	0
				8602							4172	312200

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Table I-1. ECO-1 Calculation of Chiller Energy Cost for Existing Conditions

PLANT NO:	15		MASTER CHILLER NO (LEAD):	22	
BUILDING NO:	21002				
DESIGN LOAD:	240	TONS	COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-12	
			STATUS:	EXIST	
PEAK DEMAND:	188.0	KW			
CONSUMPTION:	463061	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$28,689	/YR	LOAD LIMIT:	100	%
ENERGY COST:	$11,113	/YR			
TOTAL COST:	$39,802	/YR	RATED CAPACITY:	215.0	TONS
			RATED POWER:	188.0	KW
UNIT OUTPUT COST:	$185	/TON*YR	RATED EFFICIENCY:	0.874	KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3	S	7.2	0.0	37	48.9	7.2	3	15	26	48.9	7	342
8	S	19.2	0.0	50	48.9	19.2	9	15	26	48.9	30	1467
13	S	31.2	0.0	65	48.9	31.2	15	15	26	48.9	65	3179
18	S	43.2	0.0	83	48.9	43.2	20	20	26	48.9	83	4059
23	S	55.2	0.0	106	48.9	55.2	26	26	26	48.9	106	5183
28	S	67.2	0.0	143	50.8	67.2	31	31	27	50.8	143	7264
33	S	79.2	0.0	184	58.3	79.2	37	37	31	58.3	184	10727
38	S	91.2	0.0	232	65.8	91.2	42	42	35	65.8	232	15266
43	S	103.2	0.0	259	75.2	103.2	48	48	40	75.2	259	19477
48	S	115.2	0.0	292	84.6	115.2	54	54	45	84.6	292	24703
53	S	127.2	0.0	343	94.0	127.2	59	59	50	94.0	343	32242
58	S	139.2	0.0	381	105.3	139.2	65	65	56	105.3	381	40119
63	S	151.2	0.0	388	114.7	151.2	70	70	61	114.7	388	44504
68	S	163.2	0.0	374	127.8	163.2	76	76	68	127.8	374	47797
73	S	175.2	0.0	357	139.1	175.2	81	81	74	139.1	357	49659
78	S	187.2	0.0	308	152.3	187.2	87	87	81	152.3	308	46908
83	S	199.2	0.0	247	167.3	199.2	93	93	89	167.3	247	41323
88	S	211.2	0.0	171	180.5	211.2	98	98	96	180.5	171	30866
93	S	223.2	8.2	109	188.0	215.0	100	100	100	188.0	109	20492
98	S	235.2	20.2	59	188.0	215.0	100	100	100	188.0	59	11092
103	S	247.2	32.2	25	188.0	215.0	100	100	100	188.0	25	4700
108	S	259.2	44.2	7	188.0	215.0	100	100	100	188.0	7	1316
113	S	271.2	56.2	2	188.0	215.0	100	100	100	188.0	2	376
118	S	283.2	68.2	0	188.0	215.0	100	100	100	188.0	0	0
				8602							4172	463061

PLANT NO:	16		MASTER CHILLER NO (LEAD):	23	
BUILDING NO:	27004				
DESIGN LOAD:	486	TONS	COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-12	
			STATUS:	EXISTING	
PEAK DEMAND:	408.0	KW			
CONSUMPTION:	936039	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$62,261	/YR	LOAD LIMIT:	100	%
ENERGY COST:	$22,465	/YR			
TOTAL COST:	$84,726	/YR	RATED CAPACITY:	465.0	TONS
			RATED POWER:	408.0	KW
UNIT OUTPUT COST:	$182	/TON*YR	RATED EFFICIENCY:	0.877	KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3	S	14.6	0.0	37	106.1	14.6	3	15	26	106.1	7	743
8	S	38.9	0.0	50	106.1	38.9	8	15	26	106.1	27	2865
13	S	63.2	0.0	65	106.1	63.2	14	15	26	106.1	61	6472
18	S	87.5	0.0	83	106.1	87.5	19	19	26	106.1	83	8806
23	S	111.8	0.0	106	106.1	111.8	24	24	26	106.1	106	11247
28	S	136.1	0.0	143	106.1	136.1	29	29	26	106.1	143	15172
33	S	160.4	0.0	184	118.3	160.4	34	34	29	118.3	184	21767
38	S	184.7	0.0	232	138.7	184.7	40	40	34	138.7	232	32178
43	S	209.0	0.0	259	155.0	209.0	45	45	38	155.0	259	40145
48	S	233.3	0.0	292	171.4	233.3	50	50	42	171.4	292	50049
53	S	257.6	0.0	343	187.7	257.6	55	55	46	187.7	343	64381
58	S	281.9	0.0	381	212.2	281.9	61	61	52	212.2	381	80848
63	S	306.2	0.0	388	232.6	306.2	66	66	57	232.6	388	90249
68	S	330.5	0.0	374	253.0	330.5	71	71	62	253.0	374	94622
73	S	354.8	0.0	357	277.4	354.8	76	76	68	277.4	357	99032
78	S	379.1	0.0	308	306.0	379.1	82	82	75	306.0	308	94248
83	S	403.4	0.0	247	330.5	403.4	87	87	81	330.5	247	81634
88	S	427.7	0.0	171	359.0	427.7	92	92	88	359.0	171	61389
93	S	452.0	0.0	109	387.6	452.0	97	97	95	387.6	109	42248
98	S	476.3	11.3	59	408.0	465.0	100	100	100	408.0	59	24072
103	S	500.6	35.6	25	408.0	465.0	100	100	100	408.0	25	10200
108	S	524.9	59.9	7	408.0	465.0	100	100	100	408.0	7	2856
113	S	549.2	84.2	2	408.0	465.0	100	100	100	408.0	2	816
118	S	573.5	108.5	0	408.0	465.0	100	100	100	408.0	0	0
				8602							4165	936039

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Table I-1. ECO-1 Calculation of Chiller Energy Cost for Existing Conditions

PLANT NO:	17		MASTER CHILLER NO (LEAD):	24		MASTER CHILLER NO (LAG 1):	25	
BUILDING NO:	28000							
DESIGN LOAD:	238	TONS	COMPRESSOR:	CENT		COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER		CONDENSER:	WATER	
SIMULATION MODEL:	EQ-2M		REFRIGERANT:	R-12		REFRIGERANT:	R-12	
			STATUS:	EXISTING		STATUS:	EXISTING	
PEAK DEMAND:	170.0	KW						
CONSUMPTION:	400315	KWH/YR	CONFIGURATION:	PARALLEL		CONFIGURATION:	PARALLEL	
			MAX LEAD SETPT or PRO-RATE LOAD:	80	%	MIN LAG SETPOINT:	NA	%
DEMAND COST:	$25,942	/YR	LOAD LIMIT:	100	%	LOAD LIMIT:	100	%
ENERGY COST:	$9,608	/YR						
TOTAL COST:	$35,550	/YR	RATED CAPACITY:	110.0	TONS	RATED CAPACITY:	110.0	TONS
			RATED POWER:	85.0	KW	RATED POWER:	85.0	KW
UNIT OUTPUT COST:	$162	/TON*YR	RATED EFFICIENCY:	0.773	KW/TON	RATED EFFICIENCY:	0.773	KW/TON

% PLANT DSGN LOAD %		PLANT LOAD TONS	PLANT LOAD SHED TONS	ANNUAL OCCUR ACTUAL HR/YR	PLANT DEMAND KW	CHIL LOAD TONS	% RAT CAP ACT %	% RAT CAP ADJ %	% RAT POW %	POWER KW	ANNUAL OCCUR ADJUST HR/YR	ANNUAL ENERGY CONSUMP KWH/YR	CHIL LOAD TONS	% RAT CAP ACT %	% RAT CAP ADJ %	% RAT POW %	POWER KW	ANNUAL OCCUR ADJUST HR/YR	ANNUAL ENERGY CONSUMP KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0	0.0	0	0	0	0.0	0	0
3	S	7.1	0.0	37	22.1	7.1	6	15	26	22.1	15	332	0.0	0	0	0	0.0	0	0
8	S	19.0	0.0	50	22.1	19.0	17	17	26	22.1	50	1105	0.0	0	0	0	0.0	0	0
13	S	30.9	0.0	65	22.1	30.9	28	28	26	22.1	65	1437	0.0	0	0	0	0.0	0	0
18	S	42.8	0.0	83	28.1	42.8	39	39	33	28.1	83	2332	0.0	0	0	0	0.0	0	0
23	S	54.7	0.0	106	35.7	54.7	50	50	42	35.7	106	3784	0.0	0	0	0	0.0	0	0
28	S	66.6	0.0	143	44.2	66.6	61	61	52	44.2	143	6321	0.0	0	0	0	0.0	0	0
33	S	78.5	0.0	184	52.7	78.5	71	71	62	52.7	184	9697	0.0	0	0	0	0.0	0	0
38	S	90.4	0.0	232	57.8	45.2	41	41	34	28.9	232	6705	45.2	41	41	34	28.9	232	6705
43	S	102.3	0.0	259	65.5	51.2	47	47	39	33.2	259	8599	51.1	46	46	38	32.3	259	8366
48	S	114.2	0.0	292	73.2	57.1	52	52	43	36.6	292	10687	57.1	52	52	43	36.6	292	10687
53	S	126.1	0.0	343	81.6	63.1	57	57	48	40.8	343	13994	63.0	57	57	48	40.8	343	13994
58	S	138.0	0.0	381	91.8	69.0	63	63	54	45.9	381	17488	69.0	63	63	54	45.9	381	17488
63	S	149.9	0.0	388	100.4	75.0	68	68	59	50.2	388	19478	74.9	68	68	59	50.2	388	19478
68	S	161.8	0.0	374	110.6	80.9	74	74	65	55.3	374	20682	80.9	74	74	65	55.3	374	20682
73	S	173.7	0.0	357	120.8	86.9	79	79	71	60.4	357	21563	86.8	79	79	71	60.4	357	21563
78	S	185.6	0.0	308	131.0	92.8	84	84	77	65.5	308	20174	92.8	84	84	77	65.5	308	20174
83	S	197.5	0.0	247	144.6	98.8	90	90	85	72.3	247	17858	98.7	90	90	85	72.3	247	17858
88	S	209.4	0.0	171	156.4	104.7	95	95	92	78.2	171	13372	104.7	95	95	92	78.2	171	13372
93	S	221.3	1.3	109	170.0	110.0	100	100	100	85.0	109	9265	110.0	100	100	100	85.0	109	9265
98	S	233.2	13.2	59	170.0	110.0	100	100	100	85.0	59	5015	110.0	100	100	100	85.0	59	5015
103	S	245.1	25.1	25	170.0	110.0	100	100	100	85.0	25	2125	110.0	100	100	100	85.0	25	2125
108	S	257.0	37.0	7	170.0	110.0	100	100	100	85.0	7	595	110.0	100	100	100	85.0	7	595
113	S	268.9	48.9	2	170.0	110.0	100	100	100	85.0	2	170	110.0	100	100	100	85.0	2	170
118	S	280.8	60.8	0	170.0	110.0	100	100	100	85.0	0	0	110.0	100	100	100	85.0	0	0
				8602							4200	212778						3554	187537

PLANT NO:	18		MASTER CHILLER NO (LEAD):	27		MASTER CHILLER NO (LAG 1):	26	
BUILDING NO:	29005							
DESIGN LOAD:	836	TONS	COMPRESSOR:	CENT		COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER		CONDENSER:	WATER	
SIMULATION MODEL:	EQ-2S		REFRIGERANT:	R-11		REFRIGERANT:	R-11	
			STATUS:	EXISTING		STATUS:	EXISTING	
PEAK DEMAND:	800.0	KW						
CONSUMPTION:	1522072	KWH/YR	CONFIGURATION:	SERIES/SINGLE		CONFIGURATION:	SERIES/SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	80	%	MIN LAG SETPOINT:	40	%
DEMAND COST:	$122,080	/YR	LOAD LIMIT:	100	%	LOAD LIMIT:	100	%
ENERGY COST:	$36,530	/YR						
TOTAL COST:	$158,610	/YR	RATED CAPACITY:	436.0	TONS	RATED CAPACITY:	512.0	TONS
			RATED POWER:	400.0	KW	RATED POWER:	400.0	KW
UNIT OUTPUT COST:	$168	/TON*YR	RATED EFFICIENCY:	0.917	KW/TON	RATED EFFICIENCY:	0.781	KW/TON

% PLANT DSGN LOAD %		PLANT LOAD TONS	PLANT LOAD SHED TONS	ANNUAL OCCUR ACTUAL HR/YR	PLANT DEMAND KW	CHIL LOAD TONS	% RAT CAP ACT %	% RAT CAP ADJ %	% RAT POW %	POWER KW	ANNUAL OCCUR ADJUST HR/YR	ANNUAL ENERGY CONSUMP KWH/YR	CHIL LOAD TONS	% RAT CAP ACT %	% RAT CAP ADJ %	% RAT POW %	POWER KW	ANNUAL OCCUR ADJUST HR/YR	ANNUAL ENERGY CONSUMP KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0	0.0	0	0	0	0.0	0	0
3	S	25.1	0.0	37	104.0	25.1	6	15	26	104.0	15	1560	0.0	0	0	0	0.0	0	0
8	S	66.9	0.0	50	104.0	66.9	15	15	26	104.0	50	5200	0.0	0	0	0	0.0	0	0
13	S	108.7	0.0	65	104.0	108.7	25	25	26	104.0	65	6760	0.0	0	0	0	0.0	0	0
18	S	150.5	0.0	83	120.0	150.5	35	35	30	120.0	83	9960	0.0	0	0	0	0.0	0	0
23	S	192.3	0.0	106	148.0	192.3	44	44	37	148.0	106	15688	0.0	0	0	0	0.0	0	0
28	S	234.1	0.0	143	180.0	234.1	54	54	45	180.0	143	25740	0.0	0	0	0	0.0	0	0
33	S	275.9	0.0	184	216.0	275.9	63	63	54	216.0	184	39744	0.0	0	0	0	0.0	0	0
38	S	317.7	0.0	232	256.0	317.7	73	73	64	256.0	232	59392	0.0	0	0	0	0.0	0	0
43	S	359.5	0.0	259	256.0	154.7	35	35	30	120.0	259	31080	204.8	40	40	34	136.0	259	35224
48	S	401.3	0.0	292	288.0	196.5	45	45	38	152.0	292	44384	204.8	40	40	34	136.0	292	39712
53	S	443.1	0.0	343	320.0	238.3	55	55	46	184.0	343	63112	204.8	40	40	34	136.0	343	46648
58	S	484.9	0.0	381	356.0	280.1	64	64	55	220.0	381	83820	204.8	40	40	34	136.0	381	51816
63	S	526.7	0.0	388	396.0	321.9	74	74	65	260.0	388	100880	204.8	40	40	34	136.0	388	52768
68	S	568.5	0.0	374	404.0	210.1	48	48	40	160.0	374	59840	358.4	70	70	61	244.0	374	91256
73	S	610.3	0.0	357	440.0	251.9	58	58	49	196.0	357	69972	358.4	70	70	61	244.0	357	87108
78	S	652.1	0.0	308	476.0	293.7	67	67	58	232.0	308	71456	358.4	70	70	61	244.0	308	75152
83	S	693.9	0.0	247	520.0	335.5	77	77	69	276.0	247	68172	358.4	70	70	61	244.0	247	60268
88	S	735.7	0.0	171	568.0	223.7	51	51	42	168.0	171	28728	512.0	100	100	100	400.0	171	68400
93	S	777.5	0.0	109	608.0	265.5	61	61	52	208.0	109	22672	512.0	100	100	100	400.0	109	43600
98	S	819.3	0.0	59	644.0	307.3	70	70	61	244.0	59	14396	512.0	100	100	100	400.0	59	23600
103	S	861.1	0.0	25	688.0	349.1	80	80	72	288.0	25	7200	512.0	100	100	100	400.0	25	10000
108	S	902.9	0.0	7	740.0	390.9	90	90	85	340.0	7	2380	512.0	100	100	100	400.0	7	2800
113	S	944.7	0.0	2	792.0	432.7	99	99	98	392.0	2	784	512.0	100	100	100	400.0	2	800
118	S	986.5	38.5	0	800.0	436.0	100	100	100	400.0	0	0	512.0	100	100	100	400.0	0	0
				8602							4200	832920						3322	689152

APPENDIX I

Table I-1. ECO-1 Calculation of Chiller Energy Cost for Existing Conditions

PLANT NO:	19		MASTER CHILLER NO (LEAD):	28	
BUILDING NO:	31008				
DESIGN LOAD:	458	TONS	COMPRESSOR:	SCREW	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-22	
			STATUS:	EXISTING	
PEAK DEMAND:	301.0	KW			
CONSUMPTION:	654069	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$45,933	/YR	LOAD LIMIT:	100	%
ENERGY COST:	$15,698	/YR			
TOTAL COST:	$61,630	/YR	RATED CAPACITY:	460.0	TONS
			RATED POWER:	301.0	KW
UNIT OUTPUT COST:	$134	/TON*YR	RATED EFFICIENCY:	0.654	KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3	S	13.7	0.0	37	78.3	13.7	3	15	26	78.3	7	548
8	S	36.6	0.0	50	78.3	36.6	8	15	26	78.3	27	2114
13	S	59.5	0.0	65	78.3	59.5	13	15	26	78.3	56	4385
18	S	82.4	0.0	83	78.3	82.4	18	18	26	78.3	83	6499
23	S	105.3	0.0	106	78.3	105.3	23	23	26	78.3	106	8300
28	S	128.2	0.0	143	78.3	128.2	28	28	26	78.3	143	11197
33	S	151.1	0.0	184	84.3	151.1	33	33	28	84.3	184	15511
38	S	174.0	0.0	232	96.3	174.0	38	38	32	96.3	232	22342
43	S	196.9	0.0	259	108.4	196.9	43	43	36	108.4	259	28076
48	S	219.8	0.0	292	120.4	219.8	48	48	40	120.4	292	35157
53	S	242.7	0.0	343	132.4	242.7	53	53	44	132.4	343	45413
58	S	265.6	0.0	381	147.5	265.6	58	58	49	147.5	381	56198
63	S	288.5	0.0	388	162.5	288.5	63	63	54	162.5	388	63050
68	S	311.4	0.0	374	177.6	311.4	68	68	59	177.6	374	66422
73	S	334.3	0.0	357	192.6	334.3	73	73	64	192.6	357	68758
78	S	357.2	0.0	308	210.7	357.2	78	78	70	210.7	308	64896
83	S	380.1	0.0	247	228.8	380.1	83	83	76	228.8	247	56514
88	S	403.0	0.0	171	246.8	403.0	88	88	82	246.8	171	42203
93	S	425.9	0.0	109	267.9	425.9	93	93	89	267.9	109	29201
98	S	448.8	0.0	59	289.0	448.8	98	98	96	289.0	59	17051
103	S	471.7	11.7	25	301.0	460.0	100	100	100	301.0	25	7525
108	S	494.6	34.6	7	301.0	460.0	100	100	100	301.0	7	2107
113	S	517.5	57.5	2	301.0	460.0	100	100	100	301.0	2	602
118	S	540.4	80.4	0	301.0	460.0	100	100	100	301.0	0	0
				8602							4160	654069

PLANT NO:	20		MASTER CHILLER NO (LEAD):	29	
BUILDING NO:	34008				
DESIGN LOAD:	485	TONS	COMPRESSOR:	SCREW	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-22	
			STATUS:	EXISTING	
PEAK DEMAND:	301.0	KW			
CONSUMPTION:	695935	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$45,933	/YR	LOAD LIMIT:	100	%
ENERGY COST:	$16,702	/YR			
TOTAL COST:	$62,635	/YR	RATED CAPACITY:	460.0	TONS
			RATED POWER:	301.0	KW
UNIT OUTPUT COST:	$136	/TON*YR	RATED EFFICIENCY:	0.654	KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3	S	14.6	0.0	37	78.3	14.6	3	15	26	78.3	7	548
8	S	38.8	0.0	50	78.3	38.8	8	15	26	78.3	27	2114
13	S	63.1	0.0	65	78.3	63.1	14	15	26	78.3	61	4776
18	S	87.3	0.0	83	78.3	87.3	19	19	26	78.3	83	6499
23	S	111.6	0.0	106	78.3	111.6	24	24	26	78.3	106	8300
28	S	135.8	0.0	143	78.3	135.8	30	30	26	78.3	143	11197
33	S	160.1	0.0	184	90.3	160.1	35	35	30	90.3	184	16615
38	S	184.3	0.0	232	102.3	184.3	40	40	34	102.3	232	23734
43	S	208.6	0.0	259	114.4	208.6	45	45	38	114.4	259	29630
48	S	232.8	0.0	292	126.4	232.8	51	51	42	126.4	292	36909
53	S	257.1	0.0	343	141.5	257.1	56	56	47	141.5	343	48535
58	S	281.3	0.0	381	156.5	281.3	61	61	52	156.5	381	59627
63	S	305.6	0.0	388	171.6	305.6	66	66	57	171.6	388	66581
68	S	329.8	0.0	374	189.6	329.8	72	72	63	189.6	374	70910
73	S	354.1	0.0	357	207.7	354.1	77	77	69	207.7	357	74149
78	S	378.3	0.0	308	225.8	378.3	82	82	75	225.8	308	69546
83	S	402.6	0.0	247	246.8	402.6	88	88	82	246.8	247	60960
88	S	426.8	0.0	171	267.9	426.8	93	93	89	267.9	171	45811
93	S	451.1	0.0	109	289.0	451.1	98	98	96	289.0	109	31501
98	S	475.3	15.3	59	301.0	460.0	100	100	100	301.0	59	17759
103	S	499.6	39.6	25	301.0	460.0	100	100	100	301.0	25	7525
108	S	523.8	63.8	7	301.0	460.0	100	100	100	301.0	7	2107
113	S	548.1	88.1	2	301.0	460.0	100	100	100	301.0	2	602
118	S	572.3	112.3	0	301.0	460.0	100	100	100	301.0	0	0
				8602							4165	695935

APPENDIX I

Table I-1. ECO-1 Calculation of Chiller Energy Cost for Existing Conditions

PLANT NO:	21		MASTER CHILLER NO (LEAD):	31		MASTER CHILLER NO (LAG 1):	30		MASTER CHILLER NO (LAG 2):	32	
BUILDING NO:	36000										
DESIGN LOAD:	1155	TONS	COMPRESSOR:	CENT		COMPRESSOR:	CENT		COMPRESSOR:	CENT	
WINTER LOAD:	20	%DSGN	CONDENSER:	WATER		CONDENSER:	WATER		CONDENSER:	WATER	
SIMULATION MODEL:	EQ-3		REFRIGERANT:	R-11		REFRIGERANT:	R-11		REFRIGERANT:	R-11	
			STATUS:	EXISTING		STATUS:	EXISTING		STATUS:	EXISTING	
PEAK DEMAND:	870.0	KW	CONFIGURATION:	PARALLEL		CONFIGURATION:	PARALLEL		CONFIGURATION:	PARALLEL	
CONSUMPTION:	2153015	KWH/YR	MAX LEAD SETPT or PRO-RATE LOAD:	80	%	MIN LAG SETPOINT:	NA	%	LOAD LIMIT:	100	%
			LOAD LIMIT:	100	%	LOAD LIMIT:	100	%			
DEMAND COST:	$132,762	/YR									
ENERGY COST:	$51,672	/YR									
TOTAL COST:	$184,434	/YR	RATED CAPACITY:	400.0	TONS	RATED CAPACITY:	400.0	TONS	RATED CAPACITY:	477.0	TONS
			RATED POWER:	244.0	KW	RATED POWER:	250.0	KW	RATED POWER:	376.0	KW
UNIT OUTPUT COST:	$144	/TON*YR	RATED EFFICIENCY:	0.610	KW/TON	RATED EFFICIENCY:	0.625	KW/TON	RATED EFFICIENCY:	0.788	KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	LEAD: CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
20	W	231.0	0.0	4380	119.6	231.0	58	58	49	119.6	4380	523848
3	S	34.7	0.0	37	63.4	34.7	9	15	26	63.4	22	1395
8	S	92.4	0.0	50	63.4	92.4	23	23	26	63.4	50	3170
13	S	150.2	0.0	65	78.1	150.2	38	38	32	78.1	65	5077
18	S	207.9	0.0	83	104.9	207.9	52	52	43	104.9	83	8707
23	S	265.7	0.0	106	139.1	265.7	66	66	57	139.1	106	14745
28	S	323.4	0.0	143	168.0	161.7	40	40	34	83.0	143	11869
33	S	381.2	0.0	184	197.6	190.6	48	48	40	97.6	184	17958
38	S	438.9	0.0	232	227.2	219.5	55	55	46	112.2	232	26030
43	S	496.7	0.0	259	261.8	248.4	62	62	53	129.3	259	33489
48	S	554.4	0.0	292	296.4	277.2	69	69	60	146.4	292	42749
53	S	612.2	0.0	343	340.9	306.1	77	77	69	168.4	343	57761
58	S	669.9	0.0	381	374.1	209.8	52	52	43	104.9	381	39967
63	S	727.7	0.0	388	417.6	227.9	57	57	48	117.1	388	45435
68	S	785.4	0.0	374	461.1	246.0	62	62	53	129.3	374	48358
73	S	843.2	0.0	357	495.9	264.1	66	66	57	139.1	357	49659
78	S	900.9	0.0	308	539.4	282.2	71	71	62	151.3	308	46600
83	S	958.7	0.0	247	574.2	300.3	75	75	66	161.0	247	39767
88	S	1016.4	0.0	171	626.4	318.4	80	80	72	175.7	171	30045
93	S	1074.2	0.0	109	669.9	336.5	84	84	77	187.9	109	20481
98	S	1131.9	0.0	59	722.1	354.5	89	89	83	202.5	59	11948
103	S	1189.7	0.0	25	774.3	372.7	93	93	89	217.2	25	5430
108	S	1247.4	0.0	7	835.2	390.7	98	98	96	234.2	7	1639
113	S	1305.2	28.2	2	870.0	400.0	100	100	100	244.0	2	488
118	S	1362.9	85.9	0	870.0	400.0	100	100	100	244.0	0	0
				8602							8587	1086615

% PLANT DSGN LOAD	LAG 1: CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP	LAG 2: CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%	TONS	%	%	%	KW	HR/YR	KWH/YR	TONS	%	%	%	KW	HR/YR	KWH/YR
20	0.0	0	0	0	0.0	0	0	0.0	0	0	0	0.0	0	0
3	0.0	0	0	0	0.0	0	0	0.0	0	0	0	0.0	0	0
8	0.0	0	0	0	0.0	0	0	0.0	0	0	0	0.0	0	0
13	0.0	0	0	0	0.0	0	0	0.0	0	0	0	0.0	0	0
18	0.0	0	0	0	0.0	0	0	0.0	0	0	0	0.0	0	0
23	0.0	0	0	0	0.0	0	0	0.0	0	0	0	0.0	0	0
28	161.7	40	40	34	85.0	143	12155	0.0	0	0	0	0.0	0	0
33	190.6	48	48	40	100.0	184	18400	0.0	0	0	0	0.0	0	0
38	219.5	55	55	46	115.0	232	26680	0.0	0	0	0	0.0	0	0
43	248.4	62	62	53	132.5	259	34318	0.0	0	0	0	0.0	0	0
48	277.2	69	69	60	150.0	292	43800	0.0	0	0	0	0.0	0	0
53	306.1	77	77	69	172.5	343	59168	0.0	0	0	0	0.0	0	0
58	209.8	52	52	43	107.5	381	40958	250.3	52	52	43	161.7	381	61608
63	227.9	57	57	48	120.0	388	46560	271.9	57	57	48	180.5	388	70034
68	246.0	62	62	53	132.5	374	49555	293.4	62	62	53	199.3	374	74538
73	264.1	66	66	57	142.5	357	50873	315.0	66	66	57	214.3	357	76505
78	282.2	71	71	62	155.0	308	47740	336.5	71	71	62	233.1	308	71795
83	300.3	75	75	66	165.0	247	40755	358.1	75	75	66	248.2	247	61305
88	318.4	80	80	72	180.0	171	30780	379.6	80	80	72	270.7	171	46290
93	336.5	84	84	77	192.5	109	20983	401.2	84	84	77	289.5	109	31556
98	354.5	89	89	83	207.5	59	12243	422.9	89	89	83	312.1	59	18414
103	372.7	93	93	89	222.5	25	5563	444.3	93	93	89	334.6	25	8365
108	390.7	98	98	96	240.0	7	1680	466.0	98	98	96	361.0	7	2527
113	400.0	100	100	100	250.0	2	500	477.0	100	100	100	376.0	2	752
118	400.0	100	100	100	250.0	0	0	477.0	100	100	100	376.0	0	0
						3881	542711						2428	523689

APPENDIX I

Table I-1. ECO-1 Calculation of Chiller Energy Cost for Existing Conditions

PLANT NO:	22		MASTER CHILLER NO (LEAD):	33	
BUILDING NO:	36006				
DESIGN LOAD:	259	TONS	COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-11	
			STATUS:	EXISTING	
PEAK DEMAND:	185.0	KW			
CONSUMPTION:	376362	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$28,231	/YR	LOAD LIMIT:	100	%
ENERGY COST:	$9,033	/YR			
TOTAL COST:	$37,264	/YR	RATED CAPACITY:	275.0	TONS
			RATED POWER:	185.0	KW
UNIT OUTPUT COST:	$136	/TON*YR	RATED EFFICIENCY:	0.673	KW/TON

% PLANT DSGN LOAD (%)		PLANT LOAD (TONS)	PLANT LOAD SHED (TONS)	ANNUAL OCCUR ACTUAL (HR/YR)	PLANT DEMAND (KW)	CHIL LOAD (TONS)	% RAT CAP ACT (%)	% RAT CAP ADJ (%)	% RAT POW (%)	POWER (KW)	ANNUAL OCCUR ADJUST (HR/YR)	ANNUAL ENERGY CONSUMP (KWH/YR)
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3	S	7.8	0.0	37	48.1	7.8	3	15	26	48.1	7	337
8	S	20.7	0.0	50	48.1	20.7	8	15	26	48.1	27	1299
13	S	33.7	0.0	65	48.1	33.7	12	15	26	48.1	52	2501
18	S	46.6	0.0	83	48.1	46.6	17	17	26	48.1	83	3992
23	S	59.6	0.0	106	48.1	59.6	22	22	26	48.1	106	5099
28	S	72.5	0.0	143	48.1	72.5	26	26	26	48.1	143	6878
33	S	85.5	0.0	184	50.0	85.5	31	31	27	50.0	184	9200
38	S	98.4	0.0	232	55.5	98.4	36	36	30	55.5	232	12876
43	S	111.4	0.0	259	62.9	111.4	41	41	34	62.9	259	16291
48	S	124.3	0.0	292	70.3	124.3	45	45	38	70.3	292	20528
53	S	137.3	0.0	343	77.7	137.3	50	50	42	77.7	343	26651
58	S	150.2	0.0	381	85.1	150.2	55	55	46	85.1	381	32423
63	S	163.2	0.0	388	92.5	163.2	59	59	50	92.5	388	35890
68	S	176.1	0.0	374	101.8	176.1	64	64	55	101.8	374	38073
73	S	189.1	0.0	357	111.0	189.1	69	69	60	111.0	357	39627
78	S	202.0	0.0	308	118.4	202.0	73	73	64	118.4	308	36467
83	S	215.0	0.0	247	129.5	215.0	78	78	70	129.5	247	31987
88	S	227.9	0.0	171	140.6	227.9	83	83	76	140.6	171	24043
93	S	240.9	0.0	109	151.7	240.9	88	88	82	151.7	109	16535
98	S	253.8	0.0	59	162.8	253.8	92	92	88	162.8	59	9605
103	S	266.8	0.0	25	175.8	266.8	97	97	95	175.8	25	4395
108	S	279.7	4.7	7	185.0	275.0	100	100	100	185.0	7	1295
113	S	292.7	17.7	2	185.0	275.0	100	100	100	185.0	2	370
118	S	305.6	30.6	0	185.0	275.0	100	100	100	185.0	0	0
				8602							4156	376362

APPENDIX I

Table I-1. ECO-1 Calculation of Chiller Energy Cost for Existing Conditions

PLANT NO:	23		MASTER CHILLER NO (LEAD):	34		
BUILDING NO:	36009					
DESIGN LOAD:	110	TONS	COMPRESSOR:	RECIP		
WINTER LOAD:	0	%DSGN	CONDENSER:	AIR		
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-22		
			STATUS:	EXISTING		
PEAK DEMAND:	95.5	KW				
CONSUMPTION:	245490	KWH/YR	CONFIGURATION:	SINGLE		
			MAX LEAD SETPT or PRO-RATE LOAD:	NA		%
DEMAND COST:	$14,573	/YR	LOAD LIMIT:	100		%
ENERGY COST:	$5,892	/YR				
TOTAL COST:	$20,465	/YR	RATED CAPACITY:	95.5		TONS
			RATED POWER:	95.5	E	KW
UNIT OUTPUT COST:	$214	/TON*YR	RATED EFFICIENCY:	1.000		KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3	S	3.3	0.0	37	22.0	3.3	3	15	23	22.0	7	154
8	S	8.8	0.0	50	22.0	8.8	9	15	23	22.0	30	660
13	S	14.3	0.0	65	22.0	14.3	15	15	23	22.0	65	1430
18	S	19.8	0.0	83	22.0	19.8	21	21	23	22.0	83	1826
23	S	25.3	0.0	106	22.0	25.3	26	26	23	22.0	106	2332
28	S	30.8	0.0	143	23.9	30.8	32	32	25	23.9	143	3418
33	S	36.3	0.0	184	28.7	36.3	38	38	30	28.7	184	5281
38	S	41.8	0.0	232	35.3	41.8	44	44	37	35.3	232	8190
43	S	47.3	0.0	259	42.0	47.3	50	50	44	42.0	259	10878
48	S	52.8	0.0	292	45.8	52.8	55	55	48	45.8	292	13374
53	S	58.3	0.0	343	50.6	58.3	61	61	53	50.6	343	17356
58	S	63.8	0.0	381	56.3	63.8	67	67	59	56.3	381	21450
63	S	69.3	0.0	388	62.1	69.3	73	73	65	62.1	388	24095
68	S	74.8	0.0	374	67.8	74.8	78	78	71	67.8	374	25357
73	S	80.3	0.0	357	74.5	80.3	84	84	78	74.5	357	26597
78	S	85.8	0.0	308	82.1	85.8	90	90	86	82.1	308	25287
83	S	91.3	0.0	247	89.8	91.3	96	96	94	89.8	247	22181
88	S	96.8	1.3	171	95.5	95.5	100	100	100	95.5	171	16331
93	S	102.3	6.8	109	95.5	95.5	100	100	100	95.5	109	10410
98	S	107.8	12.3	59	95.5	95.5	100	100	100	95.5	59	5635
103	S	113.3	17.8	25	95.5	95.5	100	100	100	95.5	25	2388
108	S	118.8	23.3	7	95.5	95.5	100	100	100	95.5	7	669
113	S	124.3	28.8	2	95.5	95.5	100	100	100	95.5	2	191
118	S	129.8	34.3	0	95.5	95.5	100	100	100	95.5	0	0
				8602							4172	245490

PLANT NO:	24		MASTER CHILLER NO (LEAD):	36		MASTER CHILLER NO (LAG 1):	35		
BUILDING NO:	36014								
DESIGN LOAD:	96 ?	TONS	COMPRESSOR:	RECIP W/ HT REC		COMPRESSOR:	ABSORP		
WINTER LOAD:	10	%DSGN	CONDENSER:	WATER		CONDENSER:	WATER		
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-22		REFRIGERANT:	LB-1		
			STATUS:	EXISTING		STATUS:	ABANDONED		
PEAK DEMAND:	87.6	KW							
CONSUMPTION:	250420	KWH/YR	CONFIGURATION:	SERIES/SINGLE		CONFIGURATION:	SERIES/SINGLE		
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%	MIN LAG SETPOINT:	NA	%	
DEMAND COST:	$13,368	/YR	LOAD LIMIT:	100	%	LOAD LIMIT:	100	%	
ENERGY COST:	$6,010	/YR							
TOTAL COST:	$19,378	/YR	RATED CAPACITY:	96.2	TONS	RATED CAPACITY:	48.0	TONS	
			RATED POWER:	87.6	KW	RATED POWER:	NA	KW	
UNIT OUTPUT COST:	$201	/TON*YR	RATED EFFICIENCY:	0.911	KW/TON	RATED EFFICIENCY:	######	KW/TON	

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
10	W	9.6	0.0	4380	20.1	9.6	10	15	23	20.1	2920	58692
3	S	2.9	0.0	37	20.1	2.9	3	15	23	20.1	7	141
8	S	7.7	0.0	50	20.1	7.7	8	15	23	20.1	27	543
13	S	12.5	0.0	65	20.1	12.5	13	15	23	20.1	56	1126
18	S	17.3	0.0	83	20.1	17.3	18	18	23	20.1	83	1668
23	S	22.1	0.0	106	20.1	22.1	23	23	23	20.1	106	2131
28	S	26.9	0.0	143	20.1	26.9	28	28	23	20.1	143	2874
33	S	31.7	0.0	184	22.8	31.7	33	33	26	22.8	184	4195
38	S	36.5	0.0	232	26.3	36.5	38	38	30	26.3	232	6102
43	S	41.3	0.0	259	31.5	41.3	43	43	36	31.5	259	8159
48	S	46.1	0.0	292	36.8	46.1	48	48	42	36.8	292	10746
53	S	50.9	0.0	343	40.3	50.9	53	53	46	40.3	343	13823
58	S	55.7	0.0	381	43.8	55.7	58	58	50	43.8	381	16688
63	S	60.5	0.0	388	48.2	60.5	63	63	55	48.2	388	18702
68	S	65.3	0.0	374	52.6	65.3	68	68	60	52.6	374	19672
73	S	70.1	0.0	357	56.9	70.1	73	73	65	56.9	357	20313
78	S	74.9	0.0	308	62.2	74.9	78	78	71	62.2	308	19158
83	S	79.7	0.0	247	67.5	79.7	83	83	77	67.5	247	16673
88	S	84.5	0.0	171	72.7	84.5	88	88	83	72.7	171	12432
93	S	89.3	0.0	109	78.8	89.3	93	93	90	78.8	109	8589
98	S	94.1	0.0	59	85.0	94.1	98	98	97	85.0	59	5015
103	S	98.9	2.7	25	87.6	96.2	100	100	100	87.6	25	2190
108	S	103.7	7.5	7	87.6	96.2	100	100	100	87.6	7	613
113	S	108.5	12.3	2	87.6	96.2	100	100	100	87.6	2	175
118	S	113.3	17.1	0	87.6	96.2	100	100	100	87.6	0	0
				8602							7080	250420

% PLANT DSGN LOAD		CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	%	%	%	KW	HR/YR	KWH/YR
10	W	0.0	0	0	0	0.0	0	0
3	S		0	0		0.0	0	0
8	S		0	0		0.0	0	0
13	S		0	0		0.0	0	0
18	S		0	0		0.0	0	0
23	S		0	0		0.0	0	0
28	S		0	0		0.0	0	0
33	S		0	0		0.0	0	0
38	S		0	0		0.0	0	0
43	S		0	0		0.0	0	0
48	S		0	0		0.0	0	0
53	S		0	0		0.0	0	0
58	S		0	0		0.0	0	0
63	S		0	0		0.0	0	0
68	S		0	0		0.0	0	0
73	S		0	0		0.0	0	0
78	S		0	0		0.0	0	0
83	S		0	0		0.0	0	0
88	S		0	0		0.0	0	0
93	S		0	0		0.0	0	0
98	S		0	0		0.0	0	0
103	S		0	0		0.0	0	0
108	S		0	0		0.0	0	0
113	S		0	0		0.0	0	0
118	S	0.0	0	0	0	0.0	0	0
							0	0

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Table I-1. ECO-1 Calculation of Chiller Energy Cost for Existing Conditions

PLANT NO:	25		MASTER CHILLER NO (LEAD):	38		MASTER CHILLER NO (LAG 1):	37
BUILDING NO:	39015						
DESIGN LOAD:	980	TONS	COMPRESSOR:	CENT		COMPRESSOR:	CENT
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER		CONDENSER:	WATER
SIMULATION MODEL:	EQ-2S		REFRIGERANT:	R-11		REFRIGERANT:	R-11
			STATUS:	EXISTING		STATUS:	EXISTING
PEAK DEMAND:	847.3	KW					
CONSUMPTION:	1581653	KWH/YR	CONFIGURATION:	SERIES/SINGLE		CONFIGURATION:	SERIES/SINGLE
			MAX LEAD SETPT or PRO-RATE LOAD:	80	%	MIN LAG SETPOINT:	40 %
DEMAND COST:	$129,298	/YR	LOAD LIMIT:	100	%	LOAD LIMIT:	100 %
ENERGY COST:	$37,960	/YR					
TOTAL COST:	$167,258	/YR	RATED CAPACITY:	584.0	TONS	RATED CAPACITY:	631.0 TONS
			RATED POWER:	458.0	KW	RATED POWER:	458.0 KW
UNIT OUTPUT COST:	$151	/TON*YR	RATED EFFICIENCY:	0.784	KW/TON	RATED EFFICIENCY:	0.726 KW/TON

% PLANT DSGN LOAD (%)		PLANT LOAD (TONS)	PLANT LOAD SHED (TONS)	ANNUAL OCCUR ACTUAL (HR/YR)	PLANT DEMAND (KW)	CHIL LOAD (TONS)	% RAT CAP ACT (%)	% RAT CAP ADJ (%)	% RAT POW (%)	POWER (KW)	ANNUAL OCCUR ADJUST (HR/YR)	ANNUAL ENERGY CONSUMP (KWH/YR)	CHIL LOAD (TONS)	% RAT CAP ACT (%)	% RAT CAP ADJ (%)	% RAT POW (%)	POWER (KW)	ANNUAL OCCUR ADJUST (HR/YR)	ANNUAL ENERGY CONSUMP (KWH/YR)
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0	0.0	0	0	0	0.0	0	0
3	S	29.4	0.0	37	119.1	29.4	5	15	26	119.1	12	1429	0.0	0	0	0	0.0	0	0
8	S	78.4	0.0	50	119.1	78.4	13	15	26	119.1	43	5121	0.0	0	0	0	0.0	0	0
13	S	127.4	0.0	65	119.1	127.4	22	22	26	119.1	65	7742	0.0	0	0	0	0.0	0	0
18	S	176.4	0.0	83	119.1	176.4	30	30	26	119.1	83	9885	0.0	0	0	0	0.0	0	0
23	S	225.4	0.0	106	151.1	225.4	39	39	33	151.1	106	16017	0.0	0	0	0	0.0	0	0
28	S	274.4	0.0	143	178.6	274.4	47	47	39	178.6	143	25540	0.0	0	0	0	0.0	0	0
33	S	323.4	0.0	184	210.7	323.4	55	55	46	210.7	184	38769	0.0	0	0	0	0.0	0	0
38	S	372.4	0.0	232	251.9	372.4	64	64	55	251.9	232	58441	0.0	0	0	0	0.0	0	0
43	S	421.4	0.0	259	288.5	421.4	72	72	63	288.5	259	74722	0.0	0	0	0	0.0	0	0
48	S	470.4	0.0	292	297.7	218.0	37	37	31	142.0	292	41464	252.4	40	40	34	155.7	292	45464
53	S	519.4	0.0	343	329.7	267.0	46	46	38	174.0	343	59682	252.4	40	40	34	155.7	343	53405
58	S	568.4	0.0	381	361.8	316.0	54	54	45	206.1	381	78524	252.4	40	40	34	155.7	381	59322
63	S	617.4	0.0	388	403.0	365.0	63	63	54	247.3	388	95952	252.4	40	40	34	155.7	388	60412
68	S	666.4	0.0	374	439.7	414.0	71	71	62	284.0	374	106216	252.4	40	40	34	155.7	374	58232
73	S	715.4	0.0	357	480.9	463.0	79	79	71	325.2	357	116096	252.4	40	40	34	155.7	357	55585
78	S	764.4	0.0	308	490.1	322.7	55	55	46	210.7	308	64898	441.7	70	70	61	279.4	308	86055
83	S	813.4	0.0	247	531.3	371.7	64	64	55	251.9	247	62219	441.7	70	70	61	279.4	247	69012
88	S	862.4	0.0	171	567.9	420.7	72	72	63	288.5	171	49334	441.7	70	70	61	279.4	171	47777
93	S	911.4	0.0	109	641.2	280.4	48	48	40	183.2	109	19969	631.0	100	100	100	458.0	109	49922
98	S	960.4	0.0	59	673.3	329.4	56	56	47	215.3	59	12703	631.0	100	100	100	458.0	59	27022
103	S	1009.4	0.0	25	714.5	378.4	65	65	56	256.5	25	6413	631.0	100	100	100	458.0	25	11450
108	S	1058.4	0.0	7	751.1	427.4	73	73	64	293.1	7	2052	631.0	100	100	100	458.0	7	3206
113	S	1107.4	0.0	2	801.5	476.4	82	82	75	343.5	2	687	631.0	100	100	100	458.0	2	916
118	S	1156.4	0.0	0	847.3	525.4	90	90	85	389.3	0	0	631.0	100	100	100	458.0	0	0
				8602							4190	953873						3063	627780

PLANT NO:	26		MASTER CHILLER NO (LEAD):	40		MASTER CHILLER NO (LAG 1):	39
BUILDING NO:	39043						
DESIGN LOAD:	1084	TONS	COMPRESSOR:	CENT		COMPRESSOR:	CENT
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER		CONDENSER:	WATER
SIMULATION MODEL:	EQ-2S		REFRIGERANT:	R-11		REFRIGERANT:	R-11
			STATUS:	EXISTING		STATUS:	EXISTING
PEAK DEMAND:	905.0	KW					
CONSUMPTION:	1908094	KWH/YR	CONFIGURATION:	SERIES/SINGLE		CONFIGURATION:	SERIES/SINGLE
			MAX LEAD SETPT or PRO-RATE LOAD:	80	%	MIN LAG SETPOINT:	40 %
DEMAND COST:	$138,103	/YR	LOAD LIMIT:	100	%	LOAD LIMIT:	100 %
ENERGY COST:	$45,794	/YR					
TOTAL COST:	$183,897	/YR	RATED CAPACITY:	560.0	TONS	RATED CAPACITY:	560.0 TONS
			RATED POWER:	452.0	KW	RATED POWER:	453.0 KW
UNIT OUTPUT COST:	$184	/TON*YR	RATED EFFICIENCY:	0.807	KW/TON	RATED EFFICIENCY:	0.809 KW/TON

% PLANT DSGN LOAD (%)		PLANT LOAD (TONS)	PLANT LOAD SHED (TONS)	ANNUAL OCCUR ACTUAL (HR/YR)	PLANT DEMAND (KW)	CHIL LOAD (TONS)	% RAT CAP ACT (%)	% RAT CAP ADJ (%)	% RAT POW (%)	POWER (KW)	ANNUAL OCCUR ADJUST (HR/YR)	ANNUAL ENERGY CONSUMP (KWH/YR)	CHIL LOAD (TONS)	% RAT CAP ACT (%)	% RAT CAP ADJ (%)	% RAT POW (%)	POWER (KW)	ANNUAL OCCUR ADJUST (HR/YR)	ANNUAL ENERGY CONSUMP (KWH/YR)
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0	0.0	0	0	0	0.0	0	0
3	S	32.5	0.0	37	117.5	32.5	6	15	26	117.5	15	1763	0.0	0	0	0	0.0	0	0
8	S	86.7	0.0	50	117.5	86.7	15	15	26	117.5	50	5875	0.0	0	0	0	0.0	0	0
13	S	140.9	0.0	65	117.5	140.9	25	25	26	117.5	65	7638	0.0	0	0	0	0.0	0	0
18	S	195.1	0.0	83	135.6	195.1	35	35	30	135.6	83	11255	0.0	0	0	0	0.0	0	0
23	S	249.3	0.0	106	171.8	249.3	45	45	38	171.8	106	18211	0.0	0	0	0	0.0	0	0
28	S	303.5	0.0	143	203.4	303.5	54	54	45	203.4	143	29086	0.0	0	0	0	0.0	0	0
33	S	357.7	0.0	184	248.6	357.7	64	64	55	248.6	184	45742	0.0	0	0	0	0.0	0	0
38	S	411.9	0.0	232	293.8	411.9	74	74	65	293.8	232	68162	0.0	0	0	0	0.0	0	0
43	S	466.1	0.0	259	316.7	242.1	43	43	36	162.7	259	42139	224.0	40	40	34	154.0	259	39886
48	S	520.3	0.0	292	352.9	296.3	53	53	44	198.9	292	58079	224.0	40	40	34	154.0	292	44968
53	S	574.5	0.0	343	398.1	350.5	63	63	54	244.1	343	83726	224.0	40	40	34	154.0	343	52822
58	S	628.7	0.0	381	438.8	404.7	72	72	63	284.8	381	108509	224.0	40	40	34	154.0	381	58674
63	S	682.9	0.0	388	470.7	290.9	52	52	43	194.4	388	75427	392.0	70	70	61	276.3	388	107204
68	S	737.1	0.0	374	515.9	345.1	62	62	53	239.6	374	89610	392.0	70	70	61	276.3	374	103336
73	S	791.3	0.0	357	556.5	399.3	71	71	62	280.2	357	100031	392.0	70	70	61	276.3	357	98639
78	S	845.5	0.0	308	642.8	285.5	51	51	42	189.8	308	58458	560.0	100	100	100	453.0	308	139524
83	S	899.7	0.0	247	688.0	339.7	61	61	52	235.0	247	58045	560.0	100	100	100	453.0	247	111891
88	S	953.9	0.0	171	728.7	393.9	70	70	61	275.7	171	47145	560.0	100	100	100	453.0	171	77463
93	S	1008.1	0.0	109	778.4	448.1	80	80	72	325.4	109	35469	560.0	100	100	100	453.0	109	49377
98	S	1062.3	0.0	59	837.2	502.3	90	90	85	384.2	59	22668	560.0	100	100	100	453.0	59	26727
103	S	1116.5	0.0	25	896.0	556.5	99	99	98	443.0	25	11075	560.0	100	100	100	453.0	25	11325
108	S	1170.7	50.7	7	905.0	560.0	100	100	100	452.0	7	3164	560.0	100	100	100	453.0	7	3171
113	S	1224.9	104.9	2	905.0	560.0	100	100	100	452.0	2	904	560.0	100	100	100	453.0	2	906
118	S	1279.1	159.1	0	905.0	560.0	100	100	100	452.0	0	0	560.0	100	100	100	453.0	0	0
				8602							4200	982181						3322	925913

APPENDIX I

Table I-1. ECO-1 Calculation of Chiller Energy Cost for Existing Conditions

PLANT NO:	27		MASTER CHILLER NO (LEAD):	41	
BUILDING NO:	41003				
DESIGN LOAD:	232	TONS	COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-12	
			STATUS:	EXISTING	
PEAK DEMAND:	199.0	KW			
CONSUMPTION:	442414	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$30,367	/YR	LOAD LIMIT:	100	%
ENERGY COST:	$10,618	/YR			
TOTAL COST:	$40,985	/YR	RATED CAPACITY:	227.5	TONS
			RATED POWER:	199.0	KW
UNIT OUTPUT COST:	$180	/TON*YR	RATED EFFICIENCY:	0.875	KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3	S	7.0	0.0	37	51.7	7.0	3	15	26	51.7	7	362
8	S	18.6	0.0	50	51.7	18.6	8	15	26	51.7	27	1396
13	S	30.2	0.0	65	51.7	30.2	13	15	26	51.7	56	2895
18	S	41.8	0.0	83	51.7	41.8	18	18	26	51.7	83	4291
23	S	53.4	0.0	106	51.7	53.4	23	23	26	51.7	106	5480
28	S	65.0	0.0	143	51.7	65.0	29	29	26	51.7	143	7393
33	S	76.6	0.0	184	57.7	76.6	34	34	29	57.7	184	10617
38	S	88.2	0.0	232	65.7	88.2	39	39	33	65.7	232	15242
43	S	99.8	0.0	259	73.6	99.8	44	44	37	73.6	259	19062
48	S	111.4	0.0	292	81.6	111.4	49	49	41	81.6	292	23827
53	S	123.0	0.0	343	89.6	123.0	54	54	45	89.6	343	30733
58	S	134.6	0.0	381	99.5	134.6	59	59	50	99.5	381	37910
63	S	146.2	0.0	388	109.5	146.2	64	64	55	109.5	388	42486
68	S	157.8	0.0	374	119.4	157.8	69	69	60	119.4	374	44656
73	S	169.4	0.0	357	129.4	169.4	74	74	65	129.4	357	46196
78	S	181.0	0.0	308	143.3	181.0	80	80	72	143.3	308	44136
83	S	192.6	0.0	247	155.2	192.6	85	85	78	155.2	247	38334
88	S	204.2	0.0	171	169.2	204.2	90	90	85	169.2	171	28933
93	S	215.8	0.0	109	183.1	215.8	95	95	92	183.1	109	19958
98	S	227.4	0.0	59	199.0	227.4	100	100	100	199.0	59	11741
103	S	239.0	11.5	25	199.0	227.5	100	100	100	199.0	25	4975
108	S	250.6	23.1	7	199.0	227.5	100	100	100	199.0	7	1393
113	S	262.2	34.7	2	199.0	227.5	100	100	100	199.0	2	398
118	S	273.8	46.3	0	199.0	227.5	100	100	100	199.0	0	0
				8602							4160	442414

PLANT NO:	28		MASTER CHILLER NO (LEAD):	42	
BUILDING NO:	42000				
DESIGN LOAD:	189	TONS	COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-11	
			STATUS:	EXISTING	
PEAK DEMAND:	190.0	KW			
CONSUMPTION:	368517	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$28,994	/YR	LOAD LIMIT:	100	%
ENERGY COST:	$8,844	/YR			
TOTAL COST:	$37,838	/YR	RATED CAPACITY:	209.0	TONS
			RATED POWER:	190.0	KW
UNIT OUTPUT COST:	$181	/TON*YR	RATED EFFICIENCY:	0.909	KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3	S	5.7	0.0	37	49.4	5.7	3	15	26	49.4	7	348
8	S	15.1	0.0	50	49.4	15.1	7	15	26	49.4	23	1136
13	S	24.6	0.0	65	49.4	24.6	12	15	26	49.4	52	2569
18	S	34.0	0.0	83	49.4	34.0	16	16	26	49.4	83	4100
23	S	43.5	0.0	106	49.4	43.5	21	21	26	49.4	106	5236
28	S	52.9	0.0	143	49.4	52.9	25	25	26	49.4	143	7064
33	S	62.4	0.0	184	49.4	62.4	30	30	26	49.4	184	9090
38	S	71.8	0.0	232	55.1	71.8	34	34	29	55.1	232	12783
43	S	81.3	0.0	259	62.7	81.3	39	39	33	62.7	259	16239
48	S	90.7	0.0	292	68.4	90.7	43	43	36	68.4	292	19973
53	S	100.2	0.0	343	76.0	100.2	48	48	40	76.0	343	26068
58	S	109.6	0.0	381	81.7	109.6	52	52	43	81.7	381	31128
63	S	119.1	0.0	388	91.2	119.1	57	57	48	91.2	388	35386
68	S	128.5	0.0	374	98.8	128.5	61	61	52	98.8	374	36951
73	S	138.0	0.0	357	108.3	138.0	66	66	57	108.3	357	38663
78	S	147.4	0.0	308	117.8	147.4	71	71	62	117.8	308	36282
83	S	156.9	0.0	247	125.4	156.9	75	75	66	125.4	247	30974
88	S	166.3	0.0	171	136.8	166.3	80	80	72	136.8	171	23393
93	S	175.8	0.0	109	146.3	175.8	84	84	77	146.3	109	15947
98	S	185.2	0.0	59	157.7	185.2	89	89	83	157.7	59	9304
103	S	194.7	0.0	25	169.1	194.7	93	93	89	169.1	25	4228
108	S	204.1	0.0	7	182.4	204.1	98	98	96	182.4	7	1277
113	S	213.6	4.6	2	190.0	209.0	100	100	100	190.0	2	380
118	S	223.0	14.0	0	190.0	209.0	100	100	100	190.0	0	0
				8602							4152	368517

APPENDIX I

Table I-1. ECO-1 Calculation of Chiller Energy Cost for Existing Conditions

PLANT NO:	29		MASTER CHILLER NO (LEAD):	43		
BUILDING NO:	50001					
DESIGN LOAD:	129	TONS	COMPRESSOR:	RECIP		
WINTER LOAD:	20	%DSGN	CONDENSER:	AIR		
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-22		
			STATUS:	EXISTING		
PEAK DEMAND:	129.2	KW				
CONSUMPTION:	412864	KWH/YR	CONFIGURATION:	SINGLE		
			MAX LEAD SETPT or PRO-RATE LOAD:	NA		%
DEMAND COST:	$19,716	/YR	LOAD LIMIT:	100		%
ENERGY COST:	$9,909	/YR				
TOTAL COST:	$29,625	/YR	RATED CAPACITY:	129.2		TONS
			RATED POWER:	129.2	E	KW
UNIT OUTPUT COST:	$229	/TON*YR	RATED EFFICIENCY:	1.000		KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
20	W	25.8	0.0	4380	29.7	25.8	20	20	23	29.7	4380	130086
3	S	3.9	0.0	37	29.7	3.9	3	15	23	29.7	7	208
8	S	10.3	0.0	50	29.7	10.3	8	15	23	29.7	27	802
13	S	16.8	0.0	65	29.7	16.8	13	15	23	29.7	56	1663
18	S	23.2	0.0	83	29.7	23.2	18	18	23	29.7	83	2465
23	S	29.7	0.0	106	29.7	29.7	23	23	23	29.7	106	3148
28	S	36.1	0.0	143	29.7	36.1	28	28	23	29.7	143	4247
33	S	42.6	0.0	184	33.6	42.6	33	33	26	33.6	184	6182
38	S	49.0	0.0	232	38.8	49.0	38	38	30	38.8	232	9002
43	S	55.5	0.0	259	46.5	55.5	43	43	36	46.5	259	12044
48	S	61.9	0.0	292	54.3	61.9	48	48	42	54.3	292	15856
53	S	68.4	0.0	343	59.4	68.4	53	53	46	59.4	343	20374
58	S	74.8	0.0	381	64.6	74.8	58	58	50	64.6	381	24613
63	S	81.3	0.0	388	71.1	81.3	63	63	55	71.1	388	27587
68	S	87.7	0.0	374	77.5	87.7	68	68	60	77.5	374	28985
73	S	94.2	0.0	357	84.0	94.2	73	73	65	84.0	357	29988
78	S	100.6	0.0	308	91.7	100.6	78	78	71	91.7	308	28244
83	S	107.1	0.0	247	99.5	107.1	83	83	77	99.5	247	24577
88	S	113.5	0.0	171	107.2	113.5	88	88	83	107.2	171	18331
93	S	120.0	0.0	109	116.3	120.0	93	93	90	116.3	109	12677
98	S	126.4	0.0	59	125.3	126.4	98	98	97	125.3	59	7393
103	S	132.9	3.7	25	129.2	129.2	100	100	100	129.2	25	3230
108	S	139.3	10.1	7	129.2	129.2	100	100	100	129.2	7	904
113	S	145.8	16.6	2	129.2	129.2	100	100	100	129.2	2	258
118	S	152.2	23.0	0	129.2	129.2	100	100	100	129.2	0	0
				8602							8540	412864

APPENDIX I

Table I-1. ECO-1 Calculation of Chiller Energy Cost for Existing Conditions

PLANT NO	30	
BUILDING NO	50004	
DESIGN LOAD:	306	TONS
WINTER LOAD	20	%DSGN
SIMULATION MODEL	EQ-3	
PEAK DEMAND:	293.8	KW
CONSUMPTION:	708672	KWH/YR
DEMAND COST	$44,834	/YR
ENERGY COST	$16,958	/YR
TOTAL COST	$61,792	/YR
UNIT OUTPUT COST	$179	/TON*YR

MASTER CHILLER NO (LEAD):	46	
COMPRESSOR:	CENT	
CONDENSER:	WATER	
REFRIGERANT:	R-11	
STATUS:	EXISTING	
CONFIGURATION:	PARALLEL	
MAX LEAD SETPT or PRO-RATE LOAD:	80	%
LOAD LIMIT:	100	%
RATED CAPACITY:	125.0	TONS
RATED POWER:	94.0	KW
RATED EFFICIENCY:	0.752	KW/TON

MASTER CHILLER NO (LAG 1):	45	
COMPRESSOR:	CENT	
CONDENSER:	WATER	
REFRIGERANT:	R-11	
STATUS	EXISTING	
CONFIGURATION:	PARALLEL	
MIN LAG SETPOINT:	NA	%
LOAD LIMIT	100	%
RATED CAPACITY:	125.0	TONS
RATED POWER:	111.0	KW
RATED EFFICIENCY:	0.888	KW/TON

MASTER CHILLER NO (LAG 2):	44	
COMPRESSOR:	CENT	
CONDENSER:	WATER	
REFRIGERANT:	R-11	
STATUS:	EXISTING	
CONFIGURATION:	PARALLEL	
LOAD LIMIT:	100	%
RATED CAPACITY:	125.0	TONS
RATED POWER:	111.0	KW
RATED EFFICIENCY:	0.888	KW/TON

Plant

% PLANT DSGN LOAD (%)		PLANT LOAD (TONS)	PLANT LOAD SHED (TONS)	ANNUAL OCCUR ACTUAL (HR/YR)	PLANT DEMAND (KW)
20	W	61.2	0.0	4360	38.5
3	S	9.2	0.0	37	24.4
8	S	24.5	0.0	50	24.4
13	S	39.8	0.0	66	25.4
18	S	55.1	0.0	83	34.8
23	S	70.4	0.0	106	44.2
28	S	85.7	0.0	143	56.4
33	S	101.0	0.0	184	69.7
38	S	116.3	0.0	232	80.0
43	S	131.6	0.0	259	90.2
48	S	146.9	0.0	292	102.5
53	S	162.2	0.0	343	114.8
58	S	177.5	0.0	381	127.1
63	S	192.8	0.0	388	141.5
68	S	208.1	0.0	374	147.5
73	S	223.4	0.0	357	161.1
78	S	238.7	0.0	308	173.9
83	S	254.0	0.0	247	186.6
88	S	269.3	0.0	171	199.0
93	S	284.6	0.0	109	214.9
98	S	299.9	0.0	59	227.5
103	S	315.2	0.0	25	243.4
108	S	330.5	0.0	7	259.1
113	S	345.8	0.0	2	278.1
118	S	361.1	0.0	0	293.8
				8602	

Lead chiller

% PLANT DSGN LOAD (%)	CHIL LOAD (TONS)	% RAT CAP ACT (%)	% RAT CAP ADJ (%)	% RAT POW (%)	POWER (KW)	ANNUAL OCCUR ADJUST (HR/YR)	ANNUAL ENERGY CONSUMP (KWH/YR)
20	61.2	49	49	41	38.5	4360	168630
3	9.2	7	15	26	24.4	17	415
8	24.5	20	20	26	24.4	50	1220
13	39.8	32	32	27	25.4	66	1661
18	55.1	44	44	37	34.8	83	2889
23	70.4	56	56	47	44.2	106	4686
28	85.7	69	69	60	56.4	143	8065
33	50.5	40	40	34	32.0	184	5888
38	58.2	47	47	39	36.7	232	8514
43	65.8	53	53	44	41.4	259	10723
48	73.5	59	59	50	47.0	292	13724
53	81.1	65	65	56	52.6	343	18042
58	88.8	71	71	62	58.3	381	22212
63	96.4	77	77	69	64.9	388	25181
68	69.4	56	56	47	44.2	374	16531
73	74.5	60	60	51	47.9	357	17100
78	79.6	64	64	55	51.7	308	15924
83	84.7	68	68	59	55.5	247	13709
88	89.8	72	72	63	59.2	171	10123
93	94.9	76	76	68	63.9	109	6965
98	100.0	80	80	72	67.7	59	3994
103	105.1	84	84	77	72.4	25	1810
108	110.2	88	88	82	77.1	7	540
113	115.3	92	92	88	82.7	2	165
118	120.4	96	96	93	87.4	0	0
						8682	378699

Lag 1 chiller

% PLANT DSGN LOAD (%)	CHIL LOAD (TONS)	% RAT CAP ACT (%)	% RAT CAP ADJ (%)	% RAT POW (%)	POWER (KW)	ANNUAL OCCUR ADJUST (HR/YR)	ANNUAL ENERGY CONSUMP (KWH/YR)	RAT CAP (TONS)	RAT POW (KW)	LOAD LIMIT (%)
20	0.0	0	0	0	0.0	0	0	125.0	111.0	1.00
3	0.0	0	0	0	0.0	0	0	125.0	111.0	1.00
8	0.0	0	0	0	0.0	0	0	125.0	111.0	1.00
13	0.0	0	0	0	0.0	0	0	125.0	111.0	1.00
18	0.0	0	0	0	0.0	0	0	125.0	111.0	1.00
23	0.0	0	0	0	0.0	0	0	125.0	111.0	1.00
28	0.0	0	0	0	0.0	0	0	125.0	111.0	1.00
33	50.5	40	40	34	37.7	184	6937	125.0	111.0	1.00
38	58.2	47	47	39	43.3	232	10046	125.0	111.0	1.00
43	65.8	53	53	44	48.8	259	12639	125.0	111.0	1.00
48	73.5	59	59	50	55.5	292	16206	125.0	111.0	1.00
53	81.1	65	65	56	62.2	343	21336	125.0	111.0	1.00
58	88.8	71	71	62	68.8	381	26213	125.0	111.0	1.00
63	96.4	77	77	69	76.6	388	29721	125.0	111.0	1.00
68	69.4	56	56	47	52.2	374	19523	125.0	111.0	1.00
73	74.5	60	60	51	56.6	357	20206	125.0	111.0	1.00
78	79.6	64	64	55	61.1	308	18819	125.0	111.0	1.00
83	84.7	68	68	59	65.5	247	16179	125.0	111.0	1.00
88	89.8	72	72	63	69.9	171	11953	125.0	111.0	1.00
93	94.9	76	76	68	75.5	109	8230	125.0	111.0	1.00
98	100.0	80	80	72	79.9	59	4714	125.0	111.0	1.00
103	105.1	84	84	77	85.5	25	2138	125.0	111.0	1.00
108	110.2	88	88	82	91.0	7	637	125.0	111.0	1.00
113	115.3	92	92	88	97.7	2	195	125.0	111.0	1.00
118	120.4	96	96	93	103.2	0	0	125.0	111.0	1.00
						3738	225691			

Lag 2 chiller

% PLANT DSGN LOAD (%)	CHIL LOAD (TONS)	% RAT CAP ACT (%)	% RAT CAP ADJ (%)	% RAT POW (%)	POWER (KW)	ANNUAL OCCUR ADJUST (HR/YR)	ANNUAL ENERGY CONSUMP (KWH/YR)
20	0.0	0	0	0	0.0	0	0
3	0.0	0	0	0	0.0	0	0
8	0.0	0	0	0	0.0	0	0
13	0.0	0	0	0	0.0	0	0
18	0.0	0	0	0	0.0	0	0
23	0.0	0	0	0	0.0	0	0
28	0.0	0	0	0	0.0	0	0
33	0.0	0	0	0	0.0	0	0
38	0.0	0	0	0	0.0	0	0
43	0.0	0	0	0	0.0	0	0
48	0.0	0	0	0	0.0	0	0
53	0.0	0	0	0	0.0	0	0
58	0.0	0	0	0	0.0	0	0
63	0.0	0	0	0	0.0	0	0
68	69.3	55	55	46	51.1	374	19111
73	74.4	60	60	51	56.6	357	20206
78	79.5	64	64	55	61.1	308	18819
83	84.6	68	68	59	65.5	247	16179
88	89.7	72	72	63	69.9	171	11953
93	94.8	76	76	68	75.5	109	8230
98	99.9	80	80	72	79.9	59	4714
103	105.0	84	84	77	85.5	25	2138
108	110.1	88	88	82	91.0	7	637
113	115.2	92	92	88	97.7	2	195
118	120.3	96	96	93	103.2	0	0
						1659	102182

APPENDIX I

Table I-1. ECO-1 Calculation of Chiller Energy Cost for Existing Conditions

PLANT NO:	31		MASTER CHILLER NO (LEAD):	48		MASTER CHILLER NO (LAG 1):	47	
BUILDING NO:	87018							
DESIGN LOAD:	902	TONS	COMPRESSOR:	CENT		COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER		CONDENSER:	WATER	
SIMULATION MODEL:	EQ-2S		REFRIGERANT:	R-11		REFRIGERANT:	R-11	
			STATUS:	EXISTING		STATUS:	EXISTING	
PEAK DEMAND:	800.0	KW						
CONSUMPTION:	1657192	KWH/YR	CONFIGURATION:	SERIES/SINGLE		CONFIGURATION:	SERIES/SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	80	%	MIN LAG SETPOINT:	40	%
DEMAND COST:	$122,080	/YR	LOAD LIMIT:	100	%	LOAD LIMIT:	100	%
ENERGY COST:	$39,773	/YR						
TOTAL COST:	$161,853	/YR	RATED CAPACITY:	436.0	TONS	RATED CAPACITY:	512.0	TONS
			RATED POWER:	400.0	KW	RATED POWER:	400.0	KW
UNIT OUTPUT COST:	$171	/TON*YR	RATED EFFICIENCY:	0.917	KW/TON	RATED EFFICIENCY:	0.781	KW/TON

% PLANT DSGN LOAD (%)		PLANT LOAD (TONS)	PLANT LOAD SHED (TONS)	ANNUAL OCCUR ACTUAL (HR/YR)	PLANT DEMAND (KW)	CHIL LOAD (TONS)	% RAT CAP ACT (%)	% RAT CAP ADJ (%)	% RAT POW (%)	POWER (KW)	ANNUAL OCCUR ADJUST (HR/YR)	ANNUAL ENERGY CONSUMP (KWH/YR)	CHIL LOAD (TONS)	% RAT CAP ACT (%)	% RAT CAP ADJ (%)	% RAT POW (%)	POWER (KW)	ANNUAL OCCUR ADJUST (HR/YR)	ANNUAL ENERGY CONSUMP (KWH/YR)
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0	0.0	0	0	0	0.0	0	0
3	S	27.1	0.0	37	104.0	27.1	6	15	26	104.0	15	1560	0.0	0	0	0	0.0	0	0
8	S	72.2	0.0	50	104.0	72.2	17	17	26	104.0	50	5200	0.0	0	0	0	0.0	0	0
13	S	117.3	0.0	65	104.0	117.3	27	27	26	104.0	65	6760	0.0	0	0	0	0.0	0	0
18	S	162.4	0.0	83	124.0	162.4	37	37	31	124.0	83	10292	0.0	0	0	0	0.0	0	0
23	S	207.5	0.0	106	160.0	207.5	48	48	40	160.0	106	16960	0.0	0	0	0	0.0	0	0
28	S	252.6	0.0	143	196.0	252.6	58	58	49	196.0	143	28028	0.0	0	0	0	0.0	0	0
33	S	297.7	0.0	184	236.0	297.7	68	68	59	236.0	184	43424	0.0	0	0	0	0.0	0	0
38	S	342.8	0.0	232	284.0	342.8	79	79	71	284.0	232	65888	0.0	0	0	0	0.0	0	0
43	S	387.9	0.0	259	276.0	183.1	42	42	35	140.0	259	36260	204.8	40	40	34	136.0	259	35224
48	S	433.0	0.0	292	308.0	228.2	52	52	43	172.0	292	50224	204.8	40	40	34	136.0	292	39712
53	S	478.1	0.0	343	352.0	273.3	63	63	54	216.0	343	74088	204.8	40	40	34	136.0	343	46648
58	S	523.2	0.0	381	392.0	318.4	73	73	64	256.0	381	97536	204.8	40	40	34	136.0	381	51816
63	S	568.3	0.0	388	404.0	209.9	48	48	40	160.0	388	62080	358.4	70	70	61	244.0	388	94672
68	S	613.4	0.0	374	440.0	255.0	58	58	49	196.0	374	73304	358.4	70	70	61	244.0	374	91256
73	S	658.5	0.0	357	484.0	300.1	69	69	60	240.0	357	85680	358.4	70	70	61	244.0	357	87108
78	S	703.6	0.0	308	528.0	345.2	79	79	71	284.0	308	87472	358.4	70	70	61	244.0	308	75152
83	S	748.7	0.0	247	580.0	236.7	54	54	45	180.0	247	44460	512.0	100	100	100	400.0	247	98800
88	S	793.8	0.0	171	624.0	281.8	65	65	56	224.0	171	38304	512.0	100	100	100	400.0	171	68400
93	S	838.9	0.0	109	664.0	326.9	75	75	66	264.0	109	28776	512.0	100	100	100	400.0	109	43600
98	S	884.0	0.0	59	712.0	372.0	85	85	78	312.0	59	18408	512.0	100	100	100	400.0	59	23600
103	S	929.1	0.0	25	772.0	417.1	96	96	93	372.0	25	9300	512.0	100	100	100	400.0	25	10000
108	S	974.2	26.2	7	800.0	436.0	100	100	100	400.0	7	2800	512.0	100	100	100	400.0	7	2800
113	S	1019.3	71.3	2	800.0	436.0	100	100	100	400.0	2	800	512.0	100	100	100	400.0	2	800
118	S	1064.4	116.4	0	800.0	436.0	100	100	100	400.0	0	0	512.0	100	100	100	400.0	0	0
				8602							4200	887604						3322	769588

PLANT NO:	32		MASTER CHILLER NO (LEAD):	49	
BUILDING NO:	91001				
DESIGN LOAD:	123	TONS	COMPRESSOR:	RECIP	
WINTER LOAD:	0	%DSGN	CONDENSER:	AIR	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-22	
			STATUS:	EXISTING	
PEAK DEMAND:	121.8	KW			
CONSUMPTION:	269948	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$18,587	/YR	LOAD LIMIT:	100	%
ENERGY COST:	$6,479	/YR			
TOTAL COST:	$25,065	/YR	RATED CAPACITY:	121.8	TONS
			RATED POWER:	121.8 E	KW
UNIT OUTPUT COST:	$206	/TON*YR	RATED EFFICIENCY:	1.000	KW/TON

% PLANT DSGN LOAD (%)		PLANT LOAD (TONS)	PLANT LOAD SHED (TONS)	ANNUAL OCCUR ACTUAL (HR/YR)	PLANT DEMAND (KW)	CHIL LOAD (TONS)	% RAT CAP ACT (%)	% RAT CAP ADJ (%)	% RAT POW (%)	POWER (KW)	ANNUAL OCCUR ADJUST (HR/YR)	ANNUAL ENERGY CONSUMP (KWH/YR)
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3	S	3.7	0.0	37	28.0	3.7	3	15	23	28.0	7	198
8	S	9.8	0.0	50	28.0	9.8	8	15	23	28.0	27	756
13	S	16.0	0.0	65	28.0	16.0	13	15	23	28.0	56	1568
18	S	22.1	0.0	83	28.0	22.1	18	18	23	28.0	83	2324
23	S	28.3	0.0	106	28.0	28.3	23	23	23	28.0	106	2968
28	S	34.4	0.0	143	28.0	34.4	28	28	23	28.0	143	4004
33	S	40.6	0.0	184	31.7	40.6	33	33	26	31.7	184	5833
38	S	46.7	0.0	232	36.5	46.7	38	38	30	36.5	232	8468
43	S	52.9	0.0	259	43.8	52.9	43	43	36	43.8	259	11344
48	S	59.0	0.0	292	51.2	59.0	48	48	42	51.2	292	14950
53	S	65.2	0.0	343	57.2	65.2	54	54	47	57.2	343	19620
58	S	71.3	0.0	381	62.1	71.3	59	59	51	62.1	381	23660
63	S	77.5	0.0	388	68.2	77.5	64	64	56	68.2	388	26462
68	S	83.6	0.0	374	74.3	83.6	69	69	61	74.3	374	27788
73	S	89.8	0.0	357	80.4	89.8	74	74	66	80.4	357	28703
78	S	95.9	0.0	308	87.7	95.9	79	79	72	87.7	308	27012
83	S	102.1	0.0	247	95.0	102.1	84	84	78	95.0	247	23465
88	S	108.2	0.0	171	102.3	108.2	89	89	84	102.3	171	17493
93	S	114.4	0.0	109	110.8	114.4	94	94	91	110.8	109	12077
98	S	120.5	0.0	59	120.6	120.5	99	99	99	120.6	59	7115
103	S	126.7	4.9	25	121.8	121.8	100	100	100	121.8	25	3045
108	S	132.8	11.0	7	121.8	121.8	100	100	100	121.8	7	853
113	S	139.0	17.2	2	121.8	121.8	100	100	100	121.8	2	244
118	S	145.1	23.3	0	121.8	121.8	100	100	100	121.8	0	0
				8602							4160	269948

APPENDIX I

Table I-2. ECO-1 Calculation of Chiller Energy Cost for New Conditions

PLANT NO:	1		MASTER CHILLER NO (LEAD):	1	
BUILDING NO:	121				
DESIGN LOAD:	138	TONS	COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-123	
			STATUS:	NEW	
PEAK DEMAND:	91.8	KW			
CONSUMPTION:	198855	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$14,009	/YR	LOAD LIMIT:	100	%
ENERGY COST:	$4,725	/YR			
TOTAL COST:	$18,733	/YR	RATED CAPACITY:	138.0	TONS
			RATED POWER:	91.8	KW
UNIT OUTPUT COST:	$136	/TON*YR	RATED EFFICIENCY:	0.665	KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3	S	4.1	0.0	37	23.9	4.1	3	30	26	23.9	4	98
8	S	11.0	0.0	50	23.9	11.0	8	30	26	23.9	13	311
13	S	17.9	0.0	65	23.9	17.9	13	30	26	23.9	28	669
18	S	24.8	0.0	83	23.9	24.8	18	30	26	23.9	50	1195
23	S	31.7	0.0	106	23.9	31.7	23	30	26	23.9	81	1936
28	S	38.6	0.0	143	23.9	38.6	28	30	26	23.9	133	3179
33	S	45.5	0.0	184	25.7	45.5	33	33	28	25.7	184	4729
38	S	52.4	0.0	232	29.4	52.4	38	38	32	29.4	232	6821
43	S	59.3	0.0	259	33.0	59.3	43	43	36	33.0	259	8547
48	S	66.2	0.0	292	36.7	66.2	48	48	40	36.7	292	10716
53	S	73.1	0.0	343	40.4	73.1	53	53	44	40.4	343	13857
58	S	80.0	0.0	381	45.0	80.0	58	58	49	45.0	381	17145
63	S	86.9	0.0	388	49.6	86.9	63	63	54	49.6	388	19245
68	S	93.8	0.0	374	54.2	93.8	68	68	59	54.2	374	20271
73	S	100.7	0.0	357	58.8	100.7	73	73	64	58.8	357	20992
78	S	107.6	0.0	308	64.3	107.6	78	78	70	64.3	308	19804
83	S	114.5	0.0	247	69.8	114.5	83	83	76	69.8	247	17241
88	S	121.4	0.0	171	75.3	121.4	88	88	82	75.3	171	12876
93	S	128.3	0.0	109	81.7	128.3	93	93	89	81.7	109	8905
98	S	135.2	0.0	59	88.1	135.2	98	98	96	88.1	59	5198
103	S	142.1	4.1	25	91.8	138.0	100	100	100	91.8	25	2295
108	S	149.0	11.0	7	91.8	138.0	100	100	100	91.8	7	643
113	S	155.9	17.9	2	91.8	138.0	100	100	100	91.8	2	184
118	S	162.8	24.8	0	91.8	138.0	100	100	100	91.8	0	0
				8602							4047	198855

PLANT NO:	2		MASTER CHILLER NO (LEAD):	2	
BUILDING NO:	135				
DESIGN LOAD:	91	TONS	COMPRESSOR:	RECIP	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-22	
			STATUS:	NEW	
PEAK DEMAND:	77.1	KW			
CONSUMPTION:	166771	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$11,765	/YR	LOAD LIMIT:	100	%
ENERGY COST:	$4,003	/YR			
TOTAL COST:	$15,768	/YR	RATED CAPACITY:	91.0	TONS
			RATED POWER:	77.1	KW
UNIT OUTPUT COST:	$173	/TON*YR	RATED EFFICIENCY:	0.847	KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3	S	2.7	0.0	37	17.7	2.7	3	30	23	17.7	4	71
8	S	7.3	0.0	50	17.7	7.3	8	30	23	17.7	13	230
13	S	11.8	0.0	65	17.7	11.8	13	30	23	17.7	28	496
18	S	16.4	0.0	83	17.7	16.4	18	30	23	17.7	50	885
23	S	20.9	0.0	106	17.7	20.9	23	30	23	17.7	81	1434
28	S	25.5	0.0	143	17.7	25.5	28	30	23	17.7	133	2354
33	S	30.0	0.0	184	20.0	30.0	33	33	26	20.0	184	3680
38	S	34.6	0.0	232	23.1	34.6	38	38	30	23.1	232	5359
43	S	39.1	0.0	259	27.8	39.1	43	43	36	27.8	259	7200
48	S	43.7	0.0	292	32.4	43.7	48	48	42	32.4	292	9461
53	S	48.2	0.0	343	35.5	48.2	53	53	46	35.5	343	12177
58	S	52.8	0.0	381	38.6	52.8	58	58	50	38.6	381	14707
63	S	57.3	0.0	388	42.4	57.3	63	63	55	42.4	388	16451
68	S	61.9	0.0	374	46.3	61.9	68	68	60	46.3	374	17316
73	S	66.4	0.0	357	50.1	66.4	73	73	65	50.1	357	17886
78	S	71.0	0.0	308	54.7	71.0	78	78	71	54.7	308	16848
83	S	75.5	0.0	247	59.4	75.5	83	83	77	59.4	247	14672
88	S	80.1	0.0	171	64.0	80.1	88	88	83	64.0	171	10944
93	S	84.6	0.0	109	69.4	84.6	93	93	90	69.4	109	7565
98	S	89.2	0.0	59	74.8	89.2	98	98	97	74.8	59	4413
103	S	93.7	2.7	25	77.1	91.0	100	100	100	77.1	25	1928
108	S	98.3	7.3	7	77.1	91.0	100	100	100	77.1	7	540
113	S	102.8	11.8	2	77.1	91.0	100	100	100	77.1	2	154
118	S	107.4	16.4	0	77.1	91.0	100	100	100	77.1	0	0
				8602							4047	166771

APPENDIX I

Table I-2. ECO-1 Calculation of Chiller Energy Cost for New Conditions

PLANT NO:	3		MASTER CHILLER NO (LEAD):	4	
BUILDING NO:	194				
DESIGN LOAD:	107	TONS	COMPRESSOR:	RECIP	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-22	
			STATUS:	NEW	
PEAK DEMAND:	91.5	KW			
CONSUMPTION:	197909	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$13,963	/YR	LOAD LIMIT:	100	%
ENERGY COST:	$4,750	/YR			
TOTAL COST:	$18,713	/YR	RATED CAPACITY:	107.0	TONS
			RATED POWER:	91.5	KW
UNIT OUTPUT COST:	$175	/TON*YR	RATED EFFICIENCY:	0.855	KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3	S	3.2	0.0	37	21.0	3.2	3	30	23	21.0	4	84
8	S	8.6	0.0	50	21.0	8.6	8	30	23	21.0	13	273
13	S	13.9	0.0	65	21.0	13.9	13	30	23	21.0	28	588
18	S	19.3	0.0	83	21.0	19.3	18	30	23	21.0	50	1050
23	S	24.6	0.0	108	21.0	24.6	23	30	23	21.0	81	1701
28	S	30.0	0.0	143	21.0	30.0	28	30	23	21.0	133	2793
33	S	35.3	0.0	184	23.8	35.3	33	33	26	23.8	184	4379
38	S	40.7	0.0	232	27.5	40.7	38	38	30	27.5	232	6380
43	S	46.0	0.0	259	32.9	46.0	43	43	36	32.9	259	8521
48	S	51.4	0.0	292	38.4	51.4	48	48	42	38.4	292	11213
53	S	56.7	0.0	343	42.1	56.7	53	53	46	42.1	343	14440
58	S	62.1	0.0	381	45.8	62.1	58	58	50	45.8	381	17450
63	S	67.4	0.0	388	50.3	67.4	63	63	55	50.3	388	19516
68	S	72.8	0.0	374	54.9	72.8	68	68	60	54.9	374	20533
73	S	78.1	0.0	357	59.5	78.1	73	73	65	59.5	357	21242
78	S	83.5	0.0	308	65.0	83.5	78	78	71	65.0	308	20020
83	S	88.8	0.0	247	70.5	88.8	83	83	77	70.5	247	17414
88	S	94.2	0.0	171	75.9	94.2	88	88	83	75.9	171	12979
93	S	99.5	0.0	109	82.4	99.5	93	93	90	82.4	109	8982
98	S	104.9	0.0	59	88.8	104.9	98	98	97	88.8	59	5239
103	S	110.2	3.2	25	91.5	107.0	100	100	100	91.5	25	2288
108	S	115.6	8.6	7	91.5	107.0	100	100	100	91.5	7	641
113	S	120.9	13.9	2	91.5	107.0	100	100	100	91.5	2	183
118	S	126.3	19.3	0	91.5	107.0	100	100	100	91.5	0	0
				8602							4047	197909

PLANT NO:	5		MASTER CHILLER NO (LEAD):	6		MASTER CHILLER NO (LAG 1):	7	
BUILDING NO:	410							
DESIGN LOAD:	238	TONS	COMPRESSOR:	CENT		COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER		CONDENSER:	WATER	
SIMULATION MODEL:	EQ-2M		REFRIGERANT:	R-123		REFRIGERANT:	R-123	
			STATUS:	NEW		STATUS:	NEW	
PEAK DEMAND:	163.8	KW						
CONSUMPTION:	351549	KWH/YR	CONFIGURATION:	PARALLEL		CONFIGURATION:	PARALLEL	
			MAX LEAD SETPT or PRO-RATE LOAD:	80	%	MIN LAG SETPOINT:	NA	%
DEMAND COST:	$24,996	/YR	LOAD LIMIT:	100	%	LOAD LIMIT:	100	%
ENERGY COST:	$8,437	/YR						
TOTAL COST:	$33,433	/YR	RATED CAPACITY:	119.0	TONS	RATED CAPACITY:	119.0	TONS
			RATED POWER:	81.9	KW	RATED POWER:	81.9	KW
UNIT OUTPUT COST:	$140	/TON*YR	RATED EFFICIENCY:	0.688	KW/TON	RATED EFFICIENCY:	0.688	KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR	TONS	%	%	%	KW	HR/YR	KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0	0.0	0	0	0	0.0	0	0
3	S	7.1	0.0	37	21.3	7.1	6	30	26	21.3	7	149	0.0	0	0	0	0.0	0	0
8	S	19.0	0.0	50	21.3	19.0	16	30	26	21.3	27	575	0.0	0	0	0	0.0	0	0
13	S	30.9	0.0	65	21.3	30.9	26	30	26	21.3	56	1193	0.0	0	0	0	0.0	0	0
18	S	42.8	0.0	83	24.6	42.8	36	36	30	24.6	83	2042	0.0	0	0	0	0.0	0	0
23	S	54.7	0.0	106	31.1	54.7	46	46	38	31.1	106	3297	0.0	0	0	0	0.0	0	0
28	S	66.6	0.0	143	38.5	66.6	56	56	47	38.5	143	5506	0.0	0	0	0	0.0	0	0
33	S	78.5	0.0	184	46.7	78.5	66	66	57	46.7	184	8593	0.0	0	0	0	0.0	0	0
38	S	90.4	0.0	232	55.7	90.4	76	76	68	55.7	232	12922	0.0	0	0	0	0.0	0	0
43	S	102.3	0.0	259	59.0	51.2	43	43	36	29.5	259	7641	51.1	43	43	36	29.5	259	7641
48	S	114.2	0.0	292	65.6	57.1	48	48	40	32.8	292	9578	57.1	48	48	40	32.8	292	9578
53	S	126.1	0.0	343	72.0	63.1	53	53	44	36.0	343	12348	63.0	53	53	44	36.0	343	12348
58	S	138.0	0.0	381	80.2	69.0	58	58	49	40.1	381	15278	69.0	58	58	49	40.1	381	15278
63	S	149.9	0.0	388	88.4	75.0	63	63	54	44.2	388	17150	74.9	63	63	54	44.2	388	17150
68	S	161.8	0.0	374	96.6	80.9	68	68	59	48.3	374	18064	80.9	68	68	59	48.3	374	18064
73	S	173.7	0.0	357	104.8	86.9	73	73	64	52.4	357	18707	86.8	73	73	64	52.4	357	18707
78	S	185.6	0.0	308	114.6	92.8	78	78	70	57.3	308	17648	92.8	78	78	70	57.3	308	17648
83	S	197.5	0.0	247	124.4	98.8	83	83	76	62.2	247	15363	98.7	83	83	76	62.2	247	15363
88	S	209.4	0.0	171	134.4	104.7	88	88	82	67.2	171	11491	104.7	88	88	82	67.2	171	11491
93	S	221.3	0.0	109	145.8	110.7	93	93	89	72.9	109	7946	110.6	93	93	89	72.9	109	7946
98	S	233.2	0.0	59	157.2	116.6	98	98	96	78.6	59	4637	116.6	98	98	96	78.6	59	4637
103	S	245.1	7.1	25	163.8	119.0	100	100	100	81.9	25	2048	119.0	100	100	100	81.9	25	2048
108	S	257.0	19.0	7	163.8	119.0	100	100	100	81.9	7	573	119.0	100	100	100	81.9	7	573
113	S	268.9	30.9	2	163.8	119.0	100	100	100	81.9	2	164	119.0	100	100	100	81.9	2	164
118	S	280.8	42.8	0	163.8	119.0	100	100	100	81.9	0	0	119.0	100	100	100	81.9	0	0
				8602							4160	192913						3322	158636

APPENDIX I

Table I-2. ECO-1 Calculation of Chiller Energy Cost for New Conditions

PLANT NO:	6		MASTER CHILLER NO (LEAD):	8
BUILDING NO:	2805			
DESIGN LOAD:	116	TONS	COMPRESSOR:	RECIP
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-22
			STATUS:	NEW
PEAK DEMAND:	99.6	KW		
CONSUMPTION:	215406	KWH/YR	CONFIGURATION:	SINGLE
			MAX LEAD SETPT or PRO-RATE LOAD:	NA %
DEMAND COST:	$15,199	/YR	LOAD LIMIT:	100 %
ENERGY COST:	$5,170	/YR		
TOTAL COST:	$20,369	/YR	RATED CAPACITY:	116.0 TONS
			RATED POWER:	99.6 KW
UNIT OUTPUT COST:	$176	/TON*YR	RATED EFFICIENCY:	0.859 KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3	S	3.5	0.0	37	22.9	3.5	3	30	23	22.9	4	92
8	S	9.3	0.0	50	22.9	9.3	8	30	23	22.9	13	298
13	S	15.1	0.0	65	22.9	15.1	13	30	23	22.9	28	641
18	S	20.9	0.0	83	22.9	20.9	18	30	23	22.9	50	1145
23	S	26.7	0.0	106	22.9	26.7	23	30	23	22.9	81	1855
28	S	32.5	0.0	143	22.9	32.5	28	30	23	22.9	133	3046
33	S	38.3	0.0	184	25.9	38.3	33	33	26	25.9	184	4768
38	S	44.1	0.0	232	29.9	44.1	38	38	30	29.9	232	6937
43	S	49.9	0.0	259	35.9	49.9	43	43	36	35.9	259	9298
48	S	55.7	0.0	292	41.8	55.7	48	48	42	41.8	292	12206
53	S	61.5	0.0	343	45.8	61.5	53	53	46	45.8	343	15709
58	S	67.3	0.0	381	49.8	67.3	58	58	50	49.8	381	18974
63	S	73.1	0.0	388	54.8	73.1	63	63	55	54.8	388	21262
68	S	78.9	0.0	374	59.8	78.9	68	68	60	59.8	374	22365
73	S	84.7	0.0	357	64.7	84.7	73	73	65	64.7	357	23098
78	S	90.5	0.0	308	70.7	90.5	78	78	71	70.7	308	21776
83	S	96.3	0.0	247	76.7	96.3	83	83	77	76.7	247	18945
88	S	102.1	0.0	171	82.7	102.1	88	88	83	82.7	171	14142
93	S	107.9	0.0	109	89.6	107.9	93	93	90	89.6	109	9766
98	S	113.7	0.0	59	96.6	113.7	98	98	97	96.6	59	5699
103	S	119.5	3.5	25	99.6	116.0	100	100	100	99.6	25	2490
108	S	125.3	9.3	7	99.6	116.0	100	100	100	99.6	7	697
113	S	131.1	15.1	2	99.6	116.0	100	100	100	99.6	2	199
118	S	136.9	20.9	0	99.6	116.0	100	100	100	99.6	0	0
				8602							4047	215406

PLANT NO:	7		MASTER CHILLER NO (LEAD):	9
BUILDING NO:	5764			
DESIGN LOAD:	201 E	TONS	COMPRESSOR:	CENT
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-123
			STATUS:	NEW
PEAK DEMAND:	136.8	KW		
CONSUMPTION:	293284	KWH/YR	CONFIGURATION:	SINGLE
			MAX LEAD SETPT or PRO-RATE LOAD:	NA %
DEMAND COST:	$20,876	/YR	LOAD LIMIT:	100 %
ENERGY COST:	$7,039	/YR		
TOTAL COST:	$27,914	/YR	RATED CAPACITY:	201.0 TONS
			RATED POWER:	136.8 KW
UNIT OUTPUT COST:	$139	/TON*YR	RATED EFFICIENCY:	0.681 KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3	S	6.0	0.0	37	35.6	6.0	3	30	26	35.6	4	142
8	S	16.1	0.0	50	35.6	16.1	8	30	26	35.6	13	463
13	S	26.1	0.0	65	35.6	26.1	13	30	26	35.6	28	997
18	S	36.2	0.0	83	35.6	36.2	18	30	26	35.6	50	1780
23	S	46.2	0.0	106	35.6	46.2	23	30	26	35.6	81	2884
28	S	56.3	0.0	143	35.6	56.3	28	30	26	35.6	133	4735
33	S	66.3	0.0	184	38.3	66.3	33	33	28	38.3	184	7047
38	S	76.4	0.0	232	43.8	76.4	38	38	32	43.8	232	10162
43	S	86.4	0.0	259	49.2	86.4	43	43	36	49.2	259	12743
48	S	96.5	0.0	292	54.7	96.5	48	48	40	54.7	292	15972
53	S	106.5	0.0	343	60.2	106.5	53	53	44	60.2	343	20649
58	S	116.6	0.0	381	67.0	116.6	58	58	49	67.0	381	25527
63	S	126.6	0.0	388	73.9	126.6	63	63	54	73.9	388	28673
68	S	136.7	0.0	374	80.7	136.7	68	68	59	80.7	374	30182
73	S	146.7	0.0	357	87.6	146.7	73	73	64	87.6	357	31273
78	S	156.8	0.0	308	95.8	156.8	78	78	70	95.8	308	29508
83	S	166.8	0.0	247	104.0	166.8	83	83	76	104.0	247	25688
88	S	176.9	0.0	171	112.2	176.9	88	88	82	112.2	171	19186
93	S	186.9	0.0	109	121.8	186.9	93	93	89	121.8	109	13276
98	S	197.0	0.0	59	131.3	197.0	98	98	96	131.3	59	7747
103	S	207.0	6.0	25	136.8	201.0	100	100	100	136.8	25	3420
108	S	217.1	16.1	7	136.8	201.0	100	100	100	136.8	7	958
113	S	227.1	26.1	2	136.8	201.0	100	100	100	136.8	2	274
118	S	237.2	36.2	0	136.8	201.0	100	100	100	136.8	0	0
				8602							4047	293284

APPENDIX I

Table I-2. ECO-1 Calculation of Chiller Energy Cost for New Conditions

PLANT NO:	8		MASTER CHILLER NO (LEAD):	11	
BUILDING NO:	5792				
DESIGN LOAD:	176	TONS	COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-123	
			STATUS:	NEW	
PEAK DEMAND:	113.2	KW			
CONSUMPTION:	253789	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$17,274	/YR	LOAD LIMIT:	100	%
ENERGY COST:	$6,091	/YR			
TOTAL COST:	$23,365	/YR	RATED CAPACITY:	170.0	TONS
			RATED POWER:	113.2	KW
UNIT OUTPUT COST:	$137	/TON*YR	RATED EFFICIENCY:	0.666	KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3	S	5.3	0.0	37	29.4	5.3	3	30	26	29.4	4	118
8	S	14.1	0.0	50	29.4	14.1	8	30	26	29.4	13	382
13	S	22.9	0.0	65	29.4	22.9	13	30	26	29.4	28	823
18	S	31.7	0.0	83	29.4	31.7	19	30	26	29.4	53	1558
23	S	40.5	0.0	106	29.4	40.5	24	30	26	29.4	85	2499
28	S	49.3	0.0	143	29.4	49.3	29	30	26	29.4	138	4057
33	S	58.1	0.0	184	32.8	58.1	34	34	29	32.8	184	6035
38	S	66.9	0.0	232	37.4	66.9	39	39	33	37.4	232	8677
43	S	75.7	0.0	259	43.0	75.7	45	45	38	43.0	259	11137
48	S	84.5	0.0	292	47.5	84.5	50	50	42	47.5	292	13870
53	S	93.3	0.0	343	52.1	93.3	55	55	46	52.1	343	17870
58	S	102.1	0.0	381	57.7	102.1	60	60	51	57.7	381	21984
63	S	110.9	0.0	388	63.4	110.9	65	65	56	63.4	388	24599
68	S	119.7	0.0	374	69.1	119.7	70	70	61	69.1	374	25843
73	S	128.5	0.0	357	77.0	128.5	76	76	68	77.0	357	27489
78	S	137.3	0.0	308	83.8	137.3	81	81	74	83.8	308	25810
83	S	146.1	0.0	247	90.6	146.1	86	86	80	90.6	247	22378
88	S	154.9	0.0	171	97.4	154.9	91	91	86	97.4	171	16655
93	S	163.7	0.0	109	105.3	163.7	96	96	93	105.3	109	11478
98	S	172.5	2.5	59	113.2	170.0	100	100	100	113.2	59	6679
103	S	181.3	11.3	25	113.2	170.0	100	100	100	113.2	25	2830
108	S	190.1	20.1	7	113.2	170.0	100	100	100	113.2	7	792
113	S	198.9	28.9	2	113.2	170.0	100	100	100	113.2	2	226
118	S	207.7	37.7	0	113.2	170.0	100	100	100	113.2	0	0
				8602							4059	253789

PLANT NO:	9		MASTER CHILLER NO (LEAD):	12		MASTER CHILLER NO (LAG 1):	13	
BUILDING NO:	7050							
DESIGN LOAD:	306	TONS	COMPRESSOR:	CENT		COMPRESSOR:	CENT	
WINTER LOAD:	15	%DSGN	CONDENSER:	WATER		CONDENSER:	WATER	
SIMULATION MODEL:	EQ-2M		REFRIGERANT:	R-123		REFRIGERANT:	R-123	
			STATUS:	NEW		STATUS:	NEW	
PEAK DEMAND:	200.6	KW						
CONSUMPTION:	544903	KWH/YR	CONFIGURATION:	PARALLEL		CONFIGURATION:	PARALLEL	
			MAX LEAD SETPT or PRO-RATE LOAD:	80	%	MIN LAG SETPOINT:	NA	%
DEMAND COST:	$30,612	/YR	LOAD LIMIT:	100	%	LOAD LIMIT:	100	%
ENERGY COST:	$13,078	/YR						
TOTAL COST:	$43,689	/YR	RATED CAPACITY:	153.0	TONS	RATED CAPACITY:	153.0	TONS
			RATED POWER:	100.3	KW	RATED POWER:	100.3	KW
UNIT OUTPUT COST:	$143	/TON*YR	RATED EFFICIENCY:	0.656	KW/TON	RATED EFFICIENCY:	0.656	KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR	TONS	%	%	%	KW	HR/YR	KWH/YR
15	W	45.9	0.0	4380	26.1	45.9	30	30	26	26.1	4380	114318	0.0	0	0	0	0.0	0	0
3	S	9.2	0.0	37	26.1	9.2	6	30	26	26.1	7	183	0.0	0	0	0	0.0	0	0
8	S	24.5	0.0	50	26.1	24.5	16	30	26	26.1	27	705	0.0	0	0	0	0.0	0	0
13	S	39.8	0.0	65	26.1	39.8	26	30	26	26.1	56	1462	0.0	0	0	0	0.0	0	0
18	S	55.1	0.0	83	30.1	55.1	36	36	30	30.1	83	2498	0.0	0	0	0	0.0	0	0
23	S	70.4	0.0	106	38.1	70.4	46	46	38	38.1	106	4039	0.0	0	0	0	0.0	0	0
28	S	85.7	0.0	143	47.1	85.7	56	56	47	47.1	143	6735	0.0	0	0	0	0.0	0	0
33	S	101.0	0.0	184	57.2	101.0	66	66	57	57.2	184	10525	0.0	0	0	0	0.0	0	0
38	S	116.3	0.0	232	68.2	116.3	76	76	68	68.2	232	15822	0.0	0	0	0	0.0	0	0
43	S	131.6	0.0	259	72.2	65.8	43	43	36	36.1	259	9350	65.8	43	43	36	36.1	259	9350
48	S	146.9	0.0	292	80.2	73.5	48	48	40	40.1	292	11709	73.4	48	48	40	40.1	292	11709
53	S	162.2	0.0	343	88.2	81.1	53	53	44	44.1	343	15126	81.1	53	53	44	44.1	343	15126
58	S	177.5	0.0	381	98.2	88.8	58	58	49	49.1	381	18707	88.7	58	58	49	49.1	381	18707
63	S	192.8	0.0	388	108.4	96.4	63	63	54	54.2	388	21030	96.4	63	63	54	54.2	388	21030
68	S	208.1	0.0	374	118.4	104.1	68	68	59	59.2	374	22141	104.0	68	68	59	59.2	374	22141
73	S	223.4	0.0	357	128.4	111.7	73	73	64	64.2	357	22919	111.7	73	73	64	64.2	357	22919
78	S	238.7	0.0	308	140.4	119.4	78	78	70	70.2	308	21622	119.3	78	78	70	70.2	308	21622
83	S	254.0	0.0	247	152.4	127.0	83	83	76	76.2	247	18821	127.0	83	83	76	76.2	247	18821
88	S	269.3	0.0	171	164.4	134.7	88	88	82	82.2	171	14056	134.6	88	88	82	82.2	171	14056
93	S	284.6	0.0	109	178.6	142.3	93	93	89	89.3	109	9734	142.3	93	93	89	89.3	109	9734
98	S	299.9	0.0	59	192.6	150.0	98	98	96	96.3	59	5682	149.9	98	98	96	96.3	59	5682
103	S	315.2	9.2	25	200.6	153.0	100	100	100	100.3	25	2508	153.0	100	100	100	100.3	25	2508
108	S	330.5	24.5	7	200.6	153.0	100	100	100	100.3	7	702	153.0	100	100	100	100.3	7	702
113	S	345.8	39.8	2	200.6	153.0	100	100	100	100.3	2	201	153.0	100	100	100	100.3	2	201
118	S	361.1	55.1	0	200.6	153.0	100	100	100	100.3	0	0	153.0	100	100	100	100.3	0	0
				8602							8540	350595						3322	194308

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Table I-2. ECO-1 Calculation of Chiller Energy Cost for New Conditions

PLANT NO:	10	
BUILDING NO:	7051	
DESIGN LOAD:	158	TONS
WINTER LOAD:	15	%DSGN
SIMULATION MODEL:	EQ-1	
PEAK DEMAND:	104.1	KW
CONSUMPTION:	282469	KWH/YR
DEMAND COST:	$15,886	/YR
ENERGY COST:	$6,779	/YR
TOTAL COST:	$22,665	/YR
UNIT OUTPUT COST:	$143	/TON-YR

MASTER CHILLER NO (LEAD):	14	
COMPRESSOR:	CENT	
CONDENSER:	WATER	
REFRIGERANT:	R-123	
STATUS:	NEW	
CONFIGURATION:	SERIES/ACTIVE	
MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
LOAD LIMIT:	100	%
RATED CAPACITY:	158.0	TONS
RATED POWER:	104.1	KW
RATED EFFICIENCY:	0.659	KW/TON

MASTER CHILLER NO (LAG 1):	15	
COMPRESSOR:	CENT	
CONDENSER:	WATER	
REFRIGERANT:	R-11	
STATUS:	EXIST	
CONFIGURATION:	SERIES/REDUND	
MIN LAG SETPOINT:	NA	%
LOAD LIMIT:	100	%
RATED CAPACITY:	170.0	TONS
RATED POWER:	121.0	KW
RATED EFFICIENCY:	0.712	KW/TON

% PLANT DSGN LOAD	PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%	TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR	TONS	%	%	%	KW	HR/YR	KWH/YR
15 W	23.7	0.0	4380	27.1	23.7	15	30	26	27.1	2190	59349	#	0	0	#	0.0	0	0
3 S	4.7	0.0	37	27.1	4.7	3	30	26	27.1	4	108		0	0		0.0	0	0
8 S	12.6	0.0	50	27.1	12.6	8	30	26	27.1	13	352		0	0		0.0	0	0
13 S	20.5	0.0	65	27.1	20.5	13	30	26	27.1	28	759		0	0		0.0	0	0
18 S	28.4	0.0	83	27.1	28.4	18	30	26	27.1	50	1355		0	0		0.0	0	0
23 S	36.3	0.0	106	27.1	36.3	23	30	26	27.1	81	2195		0	0		0.0	0	0
28 S	44.2	0.0	143	27.1	44.2	28	30	26	27.1	133	3604		0	0		0.0	0	0
33 S	52.1	0.0	184	29.1	52.1	33	33	28	29.1	184	5354		0	0		0.0	0	0
38 S	60.0	0.0	232	33.3	60.0	38	38	32	33.3	232	7726		0	0		0.0	0	0
43 S	67.9	0.0	259	37.5	67.9	43	43	36	37.5	259	9713		0	0		0.0	0	0
48 S	75.8	0.0	292	41.6	75.8	48	48	40	41.6	292	12147		0	0		0.0	0	0
53 S	83.7	0.0	343	45.8	83.7	53	53	44	45.8	343	15709		0	0		0.0	0	0
58 S	91.6	0.0	381	51.0	91.6	58	58	49	51.0	381	19431		0	0		0.0	0	0
63 S	99.5	0.0	388	56.2	99.5	63	63	54	56.2	388	21806		0	0		0.0	0	0
68 S	107.4	0.0	374	61.4	107.4	68	68	59	61.4	374	22964		0	0		0.0	0	0
73 S	115.3	0.0	357	66.6	115.3	73	73	64	66.6	357	23776		0	0		0.0	0	0
78 S	123.2	0.0	308	72.9	123.2	78	78	70	72.9	308	22453		0	0		0.0	0	0
83 S	131.1	0.0	247	79.1	131.1	83	83	76	79.1	247	19538		0	0		0.0	0	0
88 S	139.0	0.0	171	85.4	139.0	88	88	82	85.4	171	14603		0	0		0.0	0	0
93 S	146.9	0.0	109	92.6	146.9	93	93	89	92.6	109	10093		0	0		0.0	0	0
98 S	154.8	0.0	59	99.9	154.8	98	98	96	99.9	59	5894		0	0		0.0	0	0
103 S	162.7	4.7	25	104.1	158.0	100	100	100	104.1	25	2603		0	0		0.0	0	0
108 S	170.6	12.6	7	104.1	158.0	100	100	100	104.1	7	729		0	0		0.0	0	0
113 S	178.5	20.5	2	104.1	158.0	100	100	100	104.1	2	208		0	0		0.0	0	0
118 S	186.4	28.4	0	104.1	158.0	100	100	100	104.1	0	0	#	0	0	#	0.0	0	0
			8602							6237	282469						0	0

APPENDIX I

Table I-2. ECO-1 Calculation of Chiller Energy Cost for New Conditions

PLANT NO:	13		MASTER CHILLER NO (LEAD):	20	
BUILDING NO:	14020				
DESIGN LOAD:	154	TONS	COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-123	
			STATUS:	NEW	
PEAK DEMAND:	101.0	KW			
CONSUMPTION:	219473	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$15,413	/YR	LOAD LIMIT:	100	%
ENERGY COST:	$5,267	/YR			
TOTAL COST:	$20,680	/YR	RATED CAPACITY:	154.0	TONS
			RATED POWER:	101.0	KW
UNIT OUTPUT COST:	$134	/TON-YR	RATED EFFICIENCY:	0.656	KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3	S	4.6	0.0	37	26.3	4.6	3	15	26	26.3	7	184
8	S	12.3	0.0	50	26.3	12.3	8	15	26	26.3	27	710
13	S	20.0	0.0	65	26.3	20.0	13	15	26	26.3	56	1473
18	S	27.7	0.0	83	26.3	27.7	18	18	26	26.3	83	2183
23	S	35.4	0.0	106	26.3	35.4	23	23	26	26.3	106	2788
28	S	43.1	0.0	143	26.3	43.1	28	28	26	26.3	143	3761
33	S	50.8	0.0	184	28.3	50.8	33	33	28	28.3	184	5207
38	S	58.5	0.0	232	32.3	58.5	38	38	32	32.3	232	7494
43	S	66.2	0.0	259	36.4	66.2	43	43	36	36.4	259	9428
48	S	73.9	0.0	292	40.4	73.9	48	48	40	40.4	292	11797
53	S	81.6	0.0	343	44.4	81.6	53	53	44	44.4	343	15229
58	S	89.3	0.0	381	49.5	89.3	58	58	49	49.5	381	18860
63	S	97.0	0.0	388	54.5	97.0	63	63	54	54.5	388	21146
68	S	104.7	0.0	374	59.6	104.7	68	68	59	59.6	374	22290
73	S	112.4	0.0	357	64.6	112.4	73	73	64	64.6	357	23062
78	S	120.1	0.0	308	70.7	120.1	78	78	70	70.7	308	21776
83	S	127.8	0.0	247	76.8	127.8	83	83	76	76.8	247	18970
88	S	135.5	0.0	171	82.8	135.5	88	88	82	82.8	171	14159
93	S	143.2	0.0	109	89.9	143.2	93	93	89	89.9	109	9799
98	S	150.9	0.0	59	97.0	150.9	98	98	96	97.0	59	5723
103	S	158.6	4.6	25	101.0	154.0	100	100	100	101.0	25	2525
108	S	166.3	12.3	7	101.0	154.0	100	100	100	101.0	7	707
113	S	174.0	20.0	2	101.0	154.0	100	100	100	101.0	2	202
118	S	181.7	27.7	0	101.0	154.0	100	100	100	101.0	0	0
				8602							4160	219473

PLANT NO:	14		MASTER CHILLER NO (LEAD):	21	
BUILDING NO:	14023				
DESIGN LOAD:	166	TONS	COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-123	
			STATUS:	NEW	
PEAK DEMAND:	110.2	KW			
CONSUMPTION:	239506	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$16,817	/YR	LOAD LIMIT:	100	%
ENERGY COST:	$5,748	/YR			
TOTAL COST:	$22,565	/YR	RATED CAPACITY:	166.0	TONS
			RATED POWER:	110.2	KW
UNIT OUTPUT COST:	$136	/TON-YR	RATED EFFICIENCY:	0.664	KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3	S	5.0	0.0	37	28.7	5.0	3	15	26	28.7	7	201
8	S	13.3	0.0	50	28.7	13.3	8	15	26	28.7	27	775
13	S	21.6	0.0	65	28.7	21.6	13	15	26	28.7	56	1607
18	S	29.9	0.0	83	28.7	29.9	18	18	26	28.7	83	2382
23	S	38.2	0.0	106	28.7	38.2	23	23	26	28.7	106	3042
28	S	46.5	0.0	143	28.7	46.5	28	28	26	28.7	143	4104
33	S	54.8	0.0	184	30.9	54.8	33	33	28	30.9	184	5686
38	S	63.1	0.0	232	35.3	63.1	38	38	32	35.3	232	8190
43	S	71.4	0.0	259	39.7	71.4	43	43	36	39.7	259	10282
48	S	79.7	0.0	292	44.1	79.7	48	48	40	44.1	292	12877
53	S	88.0	0.0	343	48.5	88.0	53	53	44	48.5	343	16636
58	S	96.3	0.0	381	54.0	96.3	58	58	49	54.0	381	20574
63	S	104.6	0.0	388	59.5	104.6	63	63	54	59.5	388	23086
68	S	112.9	0.0	374	65.0	112.9	68	68	59	65.0	374	24310
73	S	121.2	0.0	357	70.5	121.2	73	73	64	70.5	357	25169
78	S	129.5	0.0	308	77.1	129.5	78	78	70	77.1	308	23747
83	S	137.8	0.0	247	83.8	137.8	83	83	76	83.8	247	20699
88	S	146.1	0.0	171	90.4	146.1	88	88	82	90.4	171	15458
93	S	154.4	0.0	109	98.1	154.4	93	93	89	98.1	109	10693
98	S	162.7	0.0	59	105.8	162.7	98	98	96	105.8	59	6242
103	S	171.0	5.0	25	110.2	166.0	100	100	100	110.2	25	2755
108	S	179.3	13.3	7	110.2	166.0	100	100	100	110.2	7	771
113	S	187.6	21.6	2	110.2	166.0	100	100	100	110.2	2	220
118	S	195.9	29.9	0	110.2	166.0	100	100	100	110.2	0	0
				8602							4160	239506

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Table I-2. ECO-1 Calculation of Chiller Energy Cost for New Conditions

PLANT NO:	15		MASTER CHILLER NO (LEAD):	22	
BUILDING NO:	21002				
DESIGN LOAD:	240	TONS	COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-123	
			STATUS:	NEW	
PEAK DEMAND:	169.4	KW			
CONSUMPTION:	368062	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$25,850	/YR	LOAD LIMIT:	100	%
ENERGY COST:	$8,833	/YR			
TOTAL COST:	$34,684	/YR	RATED CAPACITY:	240.0	TONS
			RATED POWER:	169.4	KW
UNIT OUTPUT COST:	$145	/TON*YR	RATED EFFICIENCY:	0.706	KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3	S	7.2	0.0	37	44.0	7.2	3	15	26	44.0	7	308
8	S	19.2	0.0	50	44.0	19.2	8	15	26	44.0	27	1188
13	S	31.2	0.0	65	44.0	31.2	13	15	26	44.0	56	2464
18	S	43.2	0.0	83	44.0	43.2	18	18	26	44.0	83	3652
23	S	55.2	0.0	106	44.0	55.2	23	23	26	44.0	106	4664
28	S	67.2	0.0	143	44.0	67.2	28	28	26	44.0	143	6292
33	S	79.2	0.0	184	47.4	79.2	33	33	28	47.4	184	8722
38	S	91.2	0.0	232	54.2	91.2	38	38	32	54.2	232	12574
43	S	103.2	0.0	259	61.0	103.2	43	43	36	61.0	259	15799
48	S	115.2	0.0	292	67.8	115.2	48	48	40	67.8	292	19798
53	S	127.2	0.0	343	74.5	127.2	53	53	44	74.5	343	25554
58	S	139.2	0.0	381	83.0	139.2	58	58	49	83.0	381	31623
63	S	151.2	0.0	388	91.5	151.2	63	63	54	91.5	388	35502
68	S	163.2	0.0	374	99.9	163.2	68	68	59	99.9	374	37363
73	S	175.2	0.0	357	108.4	175.2	73	73	64	108.4	357	38699
78	S	187.2	0.0	308	118.6	187.2	78	78	70	118.6	308	36529
83	S	199.2	0.0	247	128.7	199.2	83	83	76	128.7	247	31789
88	S	211.2	0.0	171	138.9	211.2	88	88	82	138.9	171	23752
93	S	223.2	0.0	109	150.8	223.2	93	93	89	150.8	109	16437
98	S	235.2	0.0	59	162.6	235.2	98	98	96	162.6	59	9593
103	S	247.2	7.2	25	169.4	240.0	100	100	100	169.4	25	4235
108	S	259.2	19.2	7	169.4	240.0	100	100	100	169.4	7	1186
113	S	271.2	31.2	2	169.4	240.0	100	100	100	169.4	2	339
118	S	283.2	43.2	0	169.4	240.0	100	100	100	169.4	0	0
				8602							4160	368062

PLANT NO:	16		MASTER CHILLER NO (LEAD):	23	
BUILDING NO:	27004				
DESIGN LOAD:	486	TONS	COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-123	
			STATUS:	NEW	
PEAK DEMAND:	273.6	KW			
CONSUMPTION:	627661	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$41,751	/YR	LOAD LIMIT:	100	%
ENERGY COST:	$15,064	/YR			
TOTAL COST:	$56,815	/YR	RATED CAPACITY:	465.0	TONS
			RATED POWER:	273.6	KW
UNIT OUTPUT COST:	$122	/TON*YR	RATED EFFICIENCY:	0.588	KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3	S	14.6	0.0	37	71.1	14.6	3	15	26	71.1	7	498
8	S	38.9	0.0	50	71.1	38.9	8	15	26	71.1	27	1920
13	S	63.2	0.0	65	71.1	63.2	14	15	26	71.1	61	4337
18	S	87.5	0.0	83	71.1	87.5	19	19	26	71.1	83	5901
23	S	111.8	0.0	106	71.1	111.8	24	24	26	71.1	106	7537
28	S	136.1	0.0	143	71.1	136.1	29	29	26	71.1	143	10167
33	S	160.4	0.0	184	79.3	160.4	34	34	29	79.3	184	14591
38	S	184.7	0.0	232	93.0	184.7	40	40	34	93.0	232	21576
43	S	209.0	0.0	259	104.0	209.0	45	45	38	104.0	259	26936
48	S	233.3	0.0	292	114.9	233.3	50	50	42	114.9	292	33551
53	S	257.6	0.0	343	125.9	257.6	55	55	46	125.9	343	43184
58	S	281.9	0.0	381	142.3	281.9	61	61	52	142.3	381	54216
63	S	306.2	0.0	388	156.0	306.2	66	66	57	156.0	388	60528
68	S	330.5	0.0	374	169.6	330.5	71	71	62	169.6	374	63430
73	S	354.8	0.0	357	186.0	354.8	76	76	68	186.0	357	66402
78	S	379.1	0.0	308	205.2	379.1	82	82	75	205.2	308	63202
83	S	403.4	0.0	247	221.6	403.4	87	87	81	221.6	247	54735
88	S	427.7	0.0	171	240.8	427.7	92	92	88	240.8	171	41177
93	S	452.0	0.0	109	259.9	452.0	97	97	95	259.9	109	28329
98	S	476.3	11.3	59	273.6	465.0	100	100	100	273.6	59	16142
103	S	500.6	35.6	25	273.6	465.0	100	100	100	273.6	25	6840
108	S	524.9	59.9	7	273.6	465.0	100	100	100	273.6	7	1915
113	S	549.2	84.2	2	273.6	465.0	100	100	100	273.6	2	547
118	S	573.5	108.5	0	273.6	465.0	100	100	100	273.6	0	0
				8602							4165	627661

APPENDIX I

Table I-2. ECO-1 Calculation of Chiller Energy Cost for New Conditions

PLANT NO:	17		MASTER CHILLER NO (LEAD):	24		MASTER CHILLER NO (LAG 1):	25	
BUILDING NO:	28000							
DESIGN LOAD:	238	TONS	COMPRESSOR:	CENT		COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER		CONDENSER:	WATER	
SIMULATION MODEL:	EQ-2M		REFRIGERANT:	R-123		REFRIGERANT:	R-123	
			STATUS:	NEW		STATUS:	NEW	
PEAK DEMAND:	163.8	KW						
CONSUMPTION:	352402	KWH/YR	CONFIGURATION:	PARALLEL		CONFIGURATION:	PARALLEL	
			MAX LEAD SETPT or PRO-RATE LOAD:	80	%	MIN LAG SETPOINT:	NA	%
DEMAND COST:	$24,996	/YR	LOAD LIMIT:	100	%	LOAD LIMIT:	100	%
ENERGY COST:	$8,458	/YR						
TOTAL COST:	$33,454	/YR	RATED CAPACITY:	119.0	TONS	RATED CAPACITY:	119.0	TONS
			RATED POWER:	81.9	KW	RATED POWER:	81.9	KW
UNIT OUTPUT COST:	$141	/TON*YR	RATED EFFICIENCY:	0.688	KW/TON	RATED EFFICIENCY:	0.688	KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR	TONS	%	%	%	KW	HR/YR	KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0	0.0	0	0	0	0.0	0	0
3	S	7.1	0.0	37	21.3	7.1	6	15	26	21.3	15	320	0.0	0	0	0	0.0	0	0
8	S	19.0	0.0	50	21.3	19.0	16	16	26	21.3	50	1065	0.0	0	0	0	0.0	0	0
13	S	30.9	0.0	65	21.3	30.9	26	26	26	21.3	65	1385	0.0	0	0	0	0.0	0	0
18	S	42.8	0.0	83	24.6	42.8	36	36	30	24.6	83	2042	0.0	0	0	0	0.0	0	0
23	S	54.7	0.0	106	31.1	54.7	46	46	38	31.1	106	3297	0.0	0	0	0	0.0	0	0
28	S	66.6	0.0	143	38.5	66.6	56	56	47	38.5	143	5506	0.0	0	0	0	0.0	0	0
33	S	78.5	0.0	184	46.7	78.5	66	66	57	46.7	184	8593	0.0	0	0	0	0.0	0	0
38	S	90.4	0.0	232	55.7	90.4	76	76	68	55.7	232	12922	0.0	0	0	0	0.0	0	0
43	S	102.3	0.0	259	59.0	51.2	43	43	36	29.5	259	7641	51.1	43	43	36	29.5	259	7641
48	S	114.2	0.0	292	65.6	57.1	48	48	40	32.8	292	9578	57.1	48	48	40	32.8	292	9578
53	S	126.1	0.0	343	72.0	63.1	53	53	44	36.0	343	12348	63.0	53	53	44	36.0	343	12348
58	S	138.0	0.0	381	80.2	69.0	58	58	49	40.1	381	15278	69.0	58	58	49	40.1	381	15278
63	S	149.9	0.0	388	88.4	75.0	63	63	54	44.2	388	17150	74.9	63	63	54	44.2	388	17150
68	S	161.8	0.0	374	96.6	80.9	68	68	59	48.3	374	18064	80.9	68	68	59	48.3	374	18064
73	S	173.7	0.0	357	104.8	86.9	73	73	64	52.4	357	18707	86.8	73	73	64	52.4	357	18707
78	S	185.6	0.0	308	114.6	92.8	78	78	70	57.3	308	17648	92.8	78	78	70	57.3	308	17648
83	S	197.5	0.0	247	124.4	98.8	83	83	76	62.2	247	15363	98.7	83	83	76	62.2	247	15363
88	S	209.4	0.0	171	134.4	104.7	88	88	82	67.2	171	11491	104.7	88	88	82	67.2	171	11491
93	S	221.3	0.0	109	145.8	110.7	93	93	89	72.9	109	7946	110.6	93	93	89	72.9	109	7946
98	S	233.2	0.0	59	157.2	116.6	98	98	96	78.6	59	4637	116.6	98	98	96	78.6	59	4637
103	S	245.1	7.1	25	163.8	119.0	100	100	100	81.9	25	2048	119.0	100	100	100	81.9	25	2048
108	S	257.0	19.0	7	163.8	119.0	100	100	100	81.9	7	573	119.0	100	100	100	81.9	7	573
113	S	268.9	30.9	2	163.8	119.0	100	100	100	81.9	2	164	119.0	100	100	100	81.9	2	164
118	S	280.8	42.8	0	163.8	119.0	100	100	100	81.9	0	0	119.0	100	100	100	81.9	0	0
				8602							4200	193766						3322	158636

PLANT NO:	18		MASTER CHILLER NO (LEAD):	27		MASTER CHILLER NO (LAG 1):	28	
BUILDING NO:	29005							
DESIGN LOAD:	836	TONS	COMPRESSOR:	CENT		COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER		CONDENSER:	WATER	
SIMULATION MODEL:	EQ-2S		REFRIGERANT:	R-123		REFRIGERANT:	R-123	
			STATUS:	NEW		STATUS:	NEW	
PEAK DEMAND:	495.8	KW						
CONSUMPTION:	1058637	KWH/YR	CONFIGURATION:	SERIES/SINGLE		CONFIGURATION:	SERIES/SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	80	%	MIN LAG SETPOINT:	40	%
DEMAND COST:	$75,629	/YR	LOAD LIMIT:	100	%	LOAD LIMIT:	100	%
ENERGY COST:	$25,407	/YR						
TOTAL COST:	$101,036	/YR	RATED CAPACITY:	426.6	TONS	RATED CAPACITY:	426.6	TONS
			RATED POWER:	247.8	KW	RATED POWER:	247.8	KW
UNIT OUTPUT COST:	$118	/TON*YR	RATED EFFICIENCY:	0.581	KW/TON	RATED EFFICIENCY:	0.581	KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR	TONS	%	%	%	KW	HR/YR	KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0	0.0	0	0	0	0.0	0	0
3	S	25.1	0.0	37	64.4	25.1	6	15	26	64.4	15	966	0.0	0	0	0	0.0	0	0
8	S	66.9	0.0	50	64.4	66.9	16	16	26	64.4	50	3220	0.0	0	0	0	0.0	0	0
13	S	108.7	0.0	65	64.4	108.7	25	25	26	64.4	65	4186	0.0	0	0	0	0.0	0	0
18	S	150.5	0.0	83	74.3	150.5	35	35	30	74.3	83	6167	0.0	0	0	0	0.0	0	0
23	S	192.3	0.0	106	94.2	192.3	45	45	38	94.2	106	9985	0.0	0	0	0	0.0	0	0
28	S	234.1	0.0	143	114.0	234.1	55	55	46	114.0	143	16302	0.0	0	0	0	0.0	0	0
33	S	275.9	0.0	184	138.8	275.9	65	65	56	138.8	184	25539	0.0	0	0	0	0.0	0	0
38	S	317.7	0.0	232	161.1	317.7	74	74	65	161.1	232	37375	0.0	0	0	0	0.0	0	0
43	S	359.5	0.0	259	176.0	188.9	44	44	37	91.7	259	23750	170.6	40	40	34	84.3	259	21834
48	S	401.3	0.0	292	195.8	230.7	54	54	45	111.5	292	32558	170.6	40	40	34	84.3	292	24616
53	S	443.1	0.0	343	220.6	272.5	64	64	55	136.3	343	46751	170.6	40	40	34	84.3	343	28915
58	S	484.9	0.0	381	245.4	314.3	74	74	65	161.1	381	61379	170.6	40	40	34	84.3	381	32118
63	S	526.7	0.0	388	260.2	228.1	53	53	44	109.0	388	42292	298.6	70	70	61	151.2	388	58666
68	S	568.5	0.0	374	285.0	269.9	63	63	54	133.8	374	50041	298.6	70	70	61	151.2	374	56549
73	S	610.3	0.0	357	309.8	311.7	73	73	64	158.6	357	56620	298.6	70	70	61	151.2	357	53978
78	S	652.1	0.0	308	358.8	225.5	53	53	44	109.0	308	33572	426.6	100	100	100	247.8	308	76322
83	S	693.9	0.0	247	381.6	267.3	63	63	54	133.8	247	33049	426.6	100	100	100	247.8	247	61207
88	S	735.7	0.0	171	403.9	309.1	72	72	63	156.1	171	26693	426.6	100	100	100	247.8	171	42374
93	S	777.5	0.0	109	433.7	350.9	82	82	75	185.9	109	20263	426.6	100	100	100	247.8	109	27010
98	S	819.3	0.0	59	465.9	392.7	92	92	88	218.1	59	12868	426.6	100	100	100	247.8	59	14620
103	S	861.1	7.9	25	495.6	426.6	100	100	100	247.8	25	6195	426.6	100	100	100	247.8	25	6195
108	S	902.9	49.7	7	495.6	426.6	100	100	100	247.8	7	1735	426.6	100	100	100	247.8	7	1735
113	S	944.7	91.5	2	495.6	426.6	100	100	100	247.8	2	496	426.6	100	100	100	247.8	2	496
118	S	986.5	133.3	0	495.6	426.6	100	100	100	247.8	0	0	426.6	100	100	100	247.8	0	0
				8602							4200	552002						3322	508835

APPENDIX I

Table I-2. ECO-1 Calculation of Chiller Energy Cost for New Conditions

PLANT NO:	21		MASTER CHILLER NO (LEAD):	31		MASTER CHILLER NO (LAG 1):	30	
BUILDING NO:	36000							
DESIGN LOAD:	1155	TONS	COMPRESSOR:	CENT		COMPRESSOR:	CENT	
WINTER LOAD:	20	%DSGN	CONDENSER:	WATER		CONDENSER:	WATER	
SIMULATION MODEL:	EQ-3		REFRIGERANT:	R-123		REFRIGERANT:	R-123	
			STATUS:	NEW		STATUS:	NEW	
PEAK DEMAND:	741.6	KW						
CONSUMPTION:	1919353	KWH/YR	CONFIGURATION:	PARALLEL		CONFIGURATION:	PARALLEL	
			MAX LEAD SETPT or PRO-RATE LOAD:	80	%	MIN LAG SETPOINT:	NA	%
DEMAND COST:	$113,168	/YR	LOAD LIMIT:	100	%	LOAD LIMIT:	100	%
ENERGY COST:	$46,064	/YR						
TOTAL COST:	$159,233	/YR	RATED CAPACITY:	425.7	TONS	RATED CAPACITY:	425.7	TONS
			RATED POWER:	247.2	KW	RATED POWER:	247.2	KW
UNIT OUTPUT COST:	$125	/TON-YR	RATED EFFICIENCY:	0.581	KW/TON	RATED EFFICIENCY:	0.581	KW/TON

% PLANT DSGN LOAD	PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%	TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR	TONS	%	%	%	KW	HR/YR	KWH/YR
20 W	231.0	0.0	4380	111.2	231.0	54	54	45	111.2	4380	487056	0.0	0	0	0	0.0	0	0
3 S	34.7	0.0	37	64.3	34.7	8	15	26	64.3	20	1286	0.0	0	0	0	0.0	0	0
8 S	92.4	0.0	50	64.3	92.4	22	22	26	64.3	50	3215	0.0	0	0	0	0.0	0	0
13 S	150.2	0.0	65	74.2	150.2	35	35	30	74.2	65	4823	0.0	0	0	0	0.0	0	0
18 S	207.9	0.0	83	101.4	207.9	49	49	41	101.4	83	8416	0.0	0	0	0	0.0	0	0
23 S	265.7	0.0	106	131.0	265.7	62	62	53	131.0	106	13886	0.0	0	0	0	0.0	0	0
28 S	323.4	0.0	143	168.1	323.4	76	76	68	168.1	143	24038	0.0	0	0	0	0.0	0	0
33 S	381.2	0.0	184	187.8	190.6	45	45	38	93.9	184	17278	190.6	45	45	38	93.9	184	17278
38 S	438.9	0.0	232	212.6	219.5	52	52	43	106.3	232	24662	219.5	52	52	43	106.3	232	24662
43 S	496.7	0.0	259	242.2	248.4	58	58	49	121.1	259	31365	248.4	58	58	49	121.1	259	31365
48 S	554.4	0.0	292	276.8	277.2	65	65	56	138.4	292	40413	277.2	65	65	56	138.4	292	40413
53 S	612.2	0.0	343	311.4	306.1	72	72	63	155.7	343	53405	306.1	72	72	63	155.7	343	53405
58 S	669.9	0.0	381	351.0	335.0	79	79	71	175.5	381	66866	335.0	79	79	71	175.5	381	66866
63 S	727.7	0.0	388	356.1	242.6	57	57	48	118.7	388	46056	242.6	57	57	48	118.7	388	46056
68 S	785.4	0.0	374	385.5	261.8	61	61	52	128.5	374	48059	261.8	61	61	52	128.5	374	48059
73 S	843.2	0.0	357	422.7	281.1	66	66	57	140.9	357	50301	281.1	66	66	57	140.9	357	50301
78 S	900.9	0.0	308	459.9	300.3	71	71	62	153.3	308	47216	300.3	71	71	62	153.3	308	47216
83 S	958.7	0.0	247	489.6	319.6	75	75	66	163.2	247	40310	319.6	75	75	66	163.2	247	40310
88 S	1016.4	0.0	171	534.0	338.8	80	80	72	178.0	171	30438	338.8	80	80	72	178.0	171	30438
93 S	1074.2	0.0	109	570.9	358.1	84	84	77	190.3	109	20743	358.1	84	84	77	190.3	109	20743
98 S	1131.9	0.0	59	615.8	377.3	89	89	83	205.2	59	12107	377.3	89	89	83	205.2	59	12107
103 S	1189.7	0.0	25	660.0	396.6	93	93	89	220.0	25	5500	396.6	93	93	89	220.0	25	5500
108 S	1247.4	0.0	7	711.9	415.8	98	98	98	237.3	7	1661	415.8	98	98	98	237.3	7	1661
113 S	1305.2	28.1	2	741.6	425.7	100	100	100	247.2	2	494	425.7	100	100	100	247.2	2	494
118 S	1362.9	85.8	0	741.6	425.7	100	100	100	247.2	0	0	425.7	100	100	100	247.2	0	0
			8602							8585	1079594						3738	536874

PLANT NO:	22		MASTER CHILLER NO (LEAD):	33	
BUILDING NO:	36006				
DESIGN LOAD:	259	TONS	COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-123	
			STATUS:	NEW	
PEAK DEMAND:	187.5	KW			
CONSUMPTION:	381538	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$28,613	/YR	LOAD LIMIT:	100	%
ENERGY COST:	$9,157	/YR			
TOTAL COST:	$37,769	/YR	RATED CAPACITY:	275.0	TONS
			RATED POWER:	187.5	KW
UNIT OUTPUT COST:	$137	/TON-YR	RATED EFFICIENCY:	0.682	KW/TON

% PLANT DSGN LOAD	PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%	TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
0 W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3 S	7.8	0.0	37	48.8	7.8	3	15	26	48.8	7	342
8 S	20.7	0.0	50	48.8	20.7	8	15	26	48.8	27	1318
13 S	33.7	0.0	65	48.8	33.7	12	15	26	48.8	52	2538
18 S	46.6	0.0	83	48.8	46.6	17	17	26	48.8	83	4050
23 S	59.6	0.0	106	48.8	59.6	22	22	26	48.8	106	5173
28 S	72.5	0.0	143	48.8	72.5	26	26	26	48.8	143	6978
33 S	85.5	0.0	184	50.6	85.5	31	31	27	50.6	184	9310
38 S	98.4	0.0	232	56.3	98.4	36	36	30	56.3	232	13062
43 S	111.4	0.0	259	63.8	111.4	41	41	34	63.8	259	16524
48 S	124.3	0.0	292	71.3	124.3	45	45	38	71.3	292	20820
53 S	137.3	0.0	343	78.8	137.3	50	50	42	78.8	343	27028
58 S	150.2	0.0	381	86.3	150.2	55	55	46	86.3	381	32880
63 S	163.2	0.0	388	93.8	163.2	59	59	50	93.8	388	36394
68 S	176.1	0.0	374	103.1	176.1	64	64	55	103.1	374	38559
73 S	189.1	0.0	357	112.5	189.1	69	69	60	112.5	357	40163
78 S	202.0	0.0	308	120.0	202.0	73	73	64	120.0	308	36960
83 S	215.0	0.0	247	131.3	215.0	78	78	70	131.3	247	32431
88 S	227.9	0.0	171	142.5	227.9	83	83	76	142.5	171	24368
93 S	240.9	0.0	109	153.8	240.9	88	88	82	153.8	109	16764
98 S	253.8	0.0	59	165.0	253.8	92	92	88	165.0	59	9735
103 S	266.8	0.0	25	178.1	266.8	97	97	95	178.1	25	4453
108 S	279.7	4.7	7	187.5	275.0	100	100	100	187.5	7	1313
113 S	292.7	17.7	2	187.5	275.0	100	100	100	187.5	2	375
118 S	305.8	30.6	0	187.5	275.0	100	100	100	187.5	0	0
			8602							4156	381538

APPENDIX I

Table I-2. ECO-1 Calculation of Chiller Energy Cost for New Conditions

PLANT NO:	24		MASTER CHILLER NO (LEAD):	38	
BUILDING NO:	36014				
DESIGN LOAD:	98 ?	TONS	COMPRESSOR:	RECIP	
WINTER LOAD:	10	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-22	
			STATUS:	NEW	
PEAK DEMAND:	81.8	KW			
CONSUMPTION:	233938	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$12,483	/YR	LOAD LIMIT:	100	%
ENERGY COST:	$5,615	/YR			
TOTAL COST:	$18,097	/YR	RATED CAPACITY:	98.2	TONS
			RATED POWER:	81.8	KW
UNIT OUTPUT COST:	$188	/TON*YR	RATED EFFICIENCY:	0.850	KW/TON

% PLANT DSGN LOAD (%)		PLANT LOAD (TONS)	PLANT LOAD SHED (TONS)	ANNUAL OCCUR ACTUAL (HR/YR)	PLANT DEMAND (KW)	CHIL LOAD (TONS)	% RAT CAP ACT (%)	% RAT CAP ADJ (%)	% RAT POW (%)	POWER (KW)	ANNUAL OCCUR ADJUST (HR/YR)	ANNUAL ENERGY CONSUMP (KWH/YR)
10	W	9.6	0.0	4380	18.8	9.6	10	15	23	18.8	2920	54898
3	S	2.9	0.0	37	18.8	2.9	3	15	23	18.8	7	132
8	S	7.7	0.0	50	18.8	7.7	8	15	23	18.8	27	508
13	S	12.5	0.0	65	18.8	12.5	13	15	23	18.8	56	1053
18	S	17.3	0.0	83	18.8	17.3	18	18	23	18.8	83	1560
23	S	22.1	0.0	106	18.8	22.1	23	23	23	18.8	106	1993
28	S	26.9	0.0	143	18.8	26.9	28	28	23	18.8	143	2688
33	S	31.7	0.0	184	21.3	31.7	33	33	26	21.3	184	3919
38	S	36.5	0.0	232	24.5	36.5	38	38	30	24.5	232	5684
43	S	41.3	0.0	259	29.4	41.3	43	43	36	29.4	259	7615
48	S	46.1	0.0	292	34.4	46.1	48	48	42	34.4	292	10045
53	S	50.9	0.0	343	37.6	50.9	53	53	46	37.6	343	12897
58	S	55.7	0.0	381	40.9	55.7	58	58	50	40.9	381	15583
63	S	60.5	0.0	388	45.0	60.5	63	63	55	45.0	388	17460
68	S	65.3	0.0	374	49.1	65.3	68	68	60	49.1	374	18363
73	S	70.1	0.0	357	53.2	70.1	73	73	65	53.2	357	18992
78	S	74.9	0.0	308	58.1	74.9	78	78	71	58.1	308	17895
83	S	79.7	0.0	247	63.0	79.7	83	83	77	63.0	247	15561
88	S	84.5	0.0	171	67.9	84.5	88	88	83	67.9	171	11611
93	S	89.3	0.0	109	73.6	89.3	93	93	90	73.6	109	8022
98	S	94.1	0.0	59	79.3	94.1	98	98	97	79.3	59	4679
103	S	98.9	2.7	25	81.8	98.2	100	100	100	81.8	25	2045
108	S	103.7	7.5	7	81.8	98.2	100	100	100	81.8	7	573
113	S	108.5	12.3	2	81.8	98.2	100	100	100	81.8	2	164
118	S	113.3	17.1	0	81.8	98.2	100	100	100	81.8	0	0
				8602							7080	233938

PLANT NO:	25		MASTER CHILLER NO (LEAD):	38		MASTER CHILLER NO (LAG 1):	37	
BUILDING NO:	39015							
DESIGN LOAD:	980	TONS	COMPRESSOR:	CENT		COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER		CONDENSER:	WATER	
SIMULATION MODEL:	EQ-2S		REFRIGERANT:	R-123		REFRIGERANT:	R-123	
			STATUS:	NEW		STATUS:	NEW	
PEAK DEMAND:	580.6	KW						
CONSUMPTION:	1271328	KWH/YR	CONFIGURATION:	SERIES/SINGLE		CONFIGURATION:	SERIES/SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	80	%	MIN LAG SETPOINT:	40	%
DEMAND COST:	$88,600	/YR	LOAD LIMIT:	100	%	LOAD LIMIT:	100	%
ENERGY COST:	$30,512	/YR						
TOTAL COST:	$119,111	/YR	RATED CAPACITY:	490.0	TONS	RATED CAPACITY:	490.0	TONS
			RATED POWER:	290.3	KW	RATED POWER:	290.3	KW
UNIT OUTPUT COST:	$122	/TON*YR	RATED EFFICIENCY:	0.592	KW/TON	RATED EFFICIENCY:	0.592	KW/TON

% PLANT DSGN LOAD (%)		PLANT LOAD (TONS)	PLANT LOAD SHED (TONS)	ANNUAL OCCUR ACTUAL (HR/YR)	PLANT DEMAND (KW)	CHIL LOAD (TONS)	% RAT CAP ACT (%)	% RAT CAP ADJ (%)	% RAT POW (%)	POWER (KW)	ANNUAL OCCUR ADJUST (HR/YR)	ANNUAL ENERGY CONSUMP (KWH/YR)	CHIL LOAD (TONS)	% RAT CAP ACT (%)	% RAT CAP ADJ (%)	% RAT POW (%)	POWER (KW)	ANNUAL OCCUR ADJUST (HR/YR)	ANNUAL ENERGY CONSUMP (KWH/YR)
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0	0.0	0	0	0	0.0	0	0
3	S	29.4	0.0	37	75.5	29.4	6	15	26	75.5	15	1133	0.0	0	0	0	0.0	0	0
8	S	78.4	0.0	50	75.5	78.4	16	16	26	75.5	50	3775	0.0	0	0	0	0.0	0	0
13	S	127.4	0.0	65	75.5	127.4	26	26	26	75.5	65	4908	0.0	0	0	0	0.0	0	0
18	S	176.4	0.0	83	87.1	176.4	36	36	30	87.1	83	7229	0.0	0	0	0	0.0	0	0
23	S	225.4	0.0	106	110.3	225.4	46	46	38	110.3	106	11692	0.0	0	0	0	0.0	0	0
28	S	274.4	0.0	143	136.4	274.4	56	56	47	136.4	143	19505	0.0	0	0	0	0.0	0	0
33	S	323.4	0.0	184	165.5	323.4	66	66	57	165.5	184	30452	0.0	0	0	0	0.0	0	0
38	S	372.4	0.0	232	197.4	372.4	76	76	68	197.4	232	45797	0.0	0	0	0	0.0	0	0
43	S	421.4	0.0	259	209.0	225.4	46	46	38	110.3	259	28568	196.0	40	40	34	98.7	259	25563
48	S	470.4	0.0	292	235.1	274.4	56	56	47	136.4	292	39829	196.0	40	40	34	98.7	292	28820
53	S	519.4	0.0	343	264.2	323.4	66	66	57	165.5	343	56787	196.0	40	40	34	98.7	343	33854
58	S	568.4	0.0	381	296.1	372.4	76	76	68	197.4	381	75209	196.0	40	40	34	98.7	381	37605
63	S	617.4	0.0	388	313.5	274.4	56	56	47	136.4	388	52923	343.0	70	70	61	177.1	388	68715
68	S	666.4	0.0	374	342.6	323.4	66	66	57	165.5	374	61897	343.0	70	70	61	177.1	374	66235
73	S	715.4	0.0	357	374.5	372.4	76	76	68	197.4	357	70472	343.0	70	70	61	177.1	357	63225
78	S	764.4	0.0	308	426.7	274.4	56	56	47	136.4	308	42011	490.0	100	100	100	290.3	308	89412
83	S	813.4	0.0	247	455.8	323.4	66	66	57	165.5	247	40879	490.0	100	100	100	290.3	247	71704
88	S	862.4	0.0	171	487.7	372.4	76	76	68	197.4	171	33755	490.0	100	100	100	290.3	171	49641
93	S	911.4	0.0	109	522.5	421.4	86	86	80	232.2	109	25310	490.0	100	100	100	290.3	109	31643
98	S	960.4	0.0	59	560.3	470.4	96	96	93	270.0	59	15930	490.0	100	100	100	290.3	59	17128
103	S	1009.4	29.4	25	580.6	490.0	100	100	100	290.3	25	7258	490.0	100	100	100	290.3	25	7258
108	S	1058.4	78.4	7	580.6	490.0	100	100	100	290.3	7	2032	490.0	100	100	100	290.3	7	2032
113	S	1107.4	127.4	2	580.6	490.0	100	100	100	290.3	2	581	490.0	100	100	100	290.3	2	581
118	S	1156.4	176.4	0	580.6	490.0	100	100	100	290.3	0	0	490.0	100	100	100	290.3	0	0
				8602							4200	677912						3322	593416

APPENDIX I

Table I-2. ECO-1 Calculation of Chiller Energy Cost for New Conditions

PLANT NO:	28		MASTER CHILLER NO (LEAD):	40		MASTER CHILLER NO (LAG 1):	39	
BUILDING NO:	39043							
DESIGN LOAD:	1084	TONS	COMPRESSOR:	CENT		COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER		CONDENSER:	WATER	
SIMULATION MODEL:	EQ-2S		REFRIGERANT:	R-123		REFRIGERANT:	R-123	
			STATUS:	NEW		STATUS:	NEW	
PEAK DEMAND:	688.4	KW						
CONSUMPTION:	1451490	KWH/YR	CONFIGURATION:	SERIES/SINGLE		CONFIGURATION:	SERIES/SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	80	%	MIN LAG SETPOINT:	40	%
DEMAND COST:	$105,050	/YR	LOAD LIMIT:	100	%	LOAD LIMIT:	100	%
ENERGY COST:	$34,836	/YR						
TOTAL COST:	$139,886	/YR	RATED CAPACITY:	560.0	TONS	RATED CAPACITY:	560.0	TONS
			RATED POWER:	344.2	KW	RATED POWER:	344.2	KW
UNIT OUTPUT COST:	$125	/TON'YR	RATED EFFICIENCY:	0.615	KW/TON	RATED EFFICIENCY:	0.615	KW/TON

% PLANT DSGN LOAD (%)		PLANT LOAD (TONS)	PLANT LOAD SHED (TONS)	ANNUAL OCCUR ACTUAL (HR/YR)	PLANT DEMAND (KW)	CHIL LOAD (TONS)	% RAT CAP ACT (%)	% RAT CAP ADJ (%)	% RAT POW (%)	POWER (KW)	ANNUAL OCCUR ADJUST (HR/YR)	ANNUAL ENERGY CONSUMP (KWH/YR)
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3	S	32.5	0.0	37	89.5	32.5	6	15	26	89.5	15	1343
8	S	86.7	0.0	50	89.5	86.7	15	15	26	89.5	50	4475
13	S	140.9	0.0	65	89.5	140.9	25	25	26	89.5	65	5818
18	S	195.1	0.0	83	103.3	195.1	35	35	30	103.3	83	8574
23	S	249.3	0.0	106	130.8	249.3	45	45	38	130.8	106	13865
28	S	303.5	0.0	143	154.9	303.5	54	54	45	154.9	143	22151
33	S	357.7	0.0	184	189.3	357.7	64	64	55	189.3	184	34831
38	S	411.9	0.0	232	223.7	411.9	74	74	65	223.7	232	51898
43	S	466.1	0.0	259	240.9	242.1	43	43	36	123.9	259	32090
48	S	520.3	0.0	292	268.4	296.3	53	53	44	151.4	292	44209
53	S	574.5	0.0	343	302.9	350.5	63	63	54	185.9	343	63764
58	S	628.7	0.0	381	333.8	404.7	72	72	63	216.8	381	82601
63	S	682.9	0.0	388	358.0	290.9	52	52	43	148.0	388	57424
68	S	737.1	0.0	374	392.4	345.1	62	62	53	182.4	374	68218
73	S	791.3	0.0	357	423.4	399.3	71	71	62	213.4	357	76184
78	S	845.5	0.0	308	488.8	285.5	51	51	42	144.6	308	44537
83	S	899.7	0.0	247	523.2	339.7	61	61	52	179.0	247	44213
88	S	953.9	0.0	171	554.2	393.9	70	70	61	210.0	171	35910
93	S	1008.1	0.0	109	592.0	448.1	80	80	72	247.8	109	27010
98	S	1062.3	0.0	59	636.8	502.3	90	90	85	292.6	59	17263
103	S	1116.5	0.0	25	681.5	556.5	99	99	98	337.3	25	8433
108	S	1170.7	50.7	7	688.4	560.0	100	100	100	344.2	7	2409
113	S	1224.9	104.9	2	688.4	560.0	100	100	100	344.2	2	688
118	S	1279.1	159.1	0	688.4	560.0	100	100	100	344.2	0	0
				8602							4200	747908

LAG 1 chiller:

% PLANT DSGN LOAD (%)		CHIL LOAD (TONS)	% RAT CAP ACT (%)	% RAT CAP ADJ (%)	% RAT POW (%)	POWER (KW)	ANNUAL OCCUR ADJUST (HR/YR)	ANNUAL ENERGY CONSUMP (KWH/YR)
0	W	0.0	0	0	0	0.0	0	0
3	S	0.0	0	0	0	0.0	0	0
8	S	0.0	0	0	0	0.0	0	0
13	S	0.0	0	0	0	0.0	0	0
18	S	0.0	0	0	0	0.0	0	0
23	S	0.0	0	0	0	0.0	0	0
28	S	0.0	0	0	0	0.0	0	0
33	S	0.0	0	0	0	0.0	0	0
38	S	0.0	0	0	0	0.0	0	0
43	S	224.0	40	40	34	117.0	259	30303
48	S	224.0	40	40	34	117.0	292	34164
53	S	224.0	40	40	34	117.0	343	40131
58	S	224.0	40	40	34	117.0	381	44577
63	S	392.0	70	70	61	210.0	388	81480
68	S	392.0	70	70	61	210.0	374	78540
73	S	392.0	70	70	61	210.0	357	74970
78	S	560.0	100	100	100	344.2	308	106014
83	S	560.0	100	100	100	344.2	247	85017
88	S	560.0	100	100	100	344.2	171	58858
93	S	560.0	100	100	100	344.2	109	37518
98	S	560.0	100	100	100	344.2	59	20308
103	S	560.0	100	100	100	344.2	25	8605
108	S	560.0	100	100	100	344.2	7	2409
113	S	560.0	100	100	100	344.2	2	688
118	S	560.0	100	100	100	344.2	0	0
							3322	703582

PLANT NO:	27		MASTER CHILLER NO (LEAD):	41	
BUILDING NO:	41003				
DESIGN LOAD:	232	TONS	COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-123	
			STATUS:	NEW	
PEAK DEMAND:	157.4	KW			
CONSUMPTION:	349825	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$24,019	/YR	LOAD LIMIT:	100	%
ENERGY COST:	$8,396	/YR			
TOTAL COST:	$32,415	/YR	RATED CAPACITY:	227.5	TONS
			RATED POWER:	157.4	KW
UNIT OUTPUT COST:	$142	/TON'YR	RATED EFFICIENCY:	0.692	KW/TON

% PLANT DSGN LOAD (%)		PLANT LOAD (TONS)	PLANT LOAD SHED (TONS)	ANNUAL OCCUR ACTUAL (HR/YR)	PLANT DEMAND (KW)	CHIL LOAD (TONS)	% RAT CAP ACT (%)	% RAT CAP ADJ (%)	% RAT POW (%)	POWER (KW)	ANNUAL OCCUR ADJUST (HR/YR)	ANNUAL ENERGY CONSUMP (KWH/YR)
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3	S	7.0	0.0	37	40.9	7.0	3	15	26	40.9	7	286
8	S	18.6	0.0	50	40.9	18.6	8	15	26	40.9	27	1104
13	S	30.2	0.0	65	40.9	30.2	13	15	26	40.9	56	2290
18	S	41.8	0.0	83	40.9	41.8	18	18	26	40.9	83	3395
23	S	53.4	0.0	106	40.9	53.4	23	23	26	40.9	106	4335
28	S	65.0	0.0	143	40.9	65.0	29	29	26	40.9	143	5849
33	S	76.6	0.0	184	45.6	76.6	34	34	29	45.6	184	8390
38	S	88.2	0.0	232	51.9	88.2	39	39	33	51.9	232	12041
43	S	99.8	0.0	259	58.2	99.8	44	44	37	58.2	259	15074
48	S	111.4	0.0	292	64.5	111.4	49	49	41	64.5	292	18834
53	S	123.0	0.0	343	70.8	123.0	54	54	45	70.8	343	24284
58	S	134.6	0.0	381	78.7	134.6	59	59	50	78.7	381	29985
63	S	146.2	0.0	388	86.6	146.2	64	64	55	86.6	388	33601
68	S	157.8	0.0	374	94.4	157.8	69	69	60	94.4	374	35306
73	S	169.4	0.0	357	102.3	169.4	74	74	65	102.3	357	36521
78	S	181.0	0.0	308	113.3	181.0	80	80	72	113.3	308	34896
83	S	192.6	0.0	247	122.8	192.6	85	85	78	122.8	247	30332
88	S	204.2	0.0	171	133.8	204.2	90	90	85	133.8	171	22880
93	S	215.8	0.0	109	144.8	215.8	95	95	92	144.8	109	15783
98	S	227.4	0.0	59	157.4	227.4	100	100	100	157.4	59	9287
103	S	239.0	11.5	25	157.4	227.5	100	100	100	157.4	25	3935
108	S	250.6	23.1	7	157.4	227.5	100	100	100	157.4	7	1102
113	S	262.2	34.7	2	157.4	227.5	100	100	100	157.4	2	315
118	S	273.8	46.3	0	157.4	227.5	100	100	100	157.4	0	0
				8602							4160	349825

APPENDIX I

Table I-2. ECO-1 Calculation of Chiller Energy Cost for New Conditions

PLANT NO:	28		MASTER CHILLER NO (LEAD):	42	
BUILDING NO:	42000				
DESIGN LOAD:	189	TONS	COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-123	
			STATUS:	NEW	
PEAK DEMAND:	127.0	KW			
CONSUMPTION:	275936	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$19,380	/YR	LOAD LIMIT:	100	%
ENERGY COST:	$6,622	/YR			
TOTAL COST:	$26,003	/YR	RATED CAPACITY:	188.1	TONS
			RATED POWER:	127.0	KW
UNIT OUTPUT COST:	$138	/TON*YR	RATED EFFICIENCY:	0.675	KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3	S	5.7	0.0	37	33.0	5.7	3	15	28	33.0	7	231
8	S	15.1	0.0	50	33.0	15.1	8	15	26	33.0	27	891
13	S	24.6	0.0	65	33.0	24.6	13	15	26	33.0	56	1848
18	S	34.0	0.0	83	33.0	34.0	18	18	26	33.0	83	2739
23	S	43.5	0.0	106	33.0	43.5	23	23	26	33.0	106	3498
28	S	52.9	0.0	143	33.0	52.9	28	28	26	33.0	143	4719
33	S	62.4	0.0	184	35.6	62.4	33	33	28	35.6	184	6550
38	S	71.8	0.0	232	40.6	71.8	38	38	32	40.6	232	9419
43	S	81.3	0.0	259	45.7	81.3	43	43	36	45.7	259	11836
48	S	90.7	0.0	292	50.8	90.7	48	48	40	50.8	292	14834
53	S	100.2	0.0	343	55.9	100.2	53	53	44	55.9	343	19174
58	S	109.6	0.0	381	62.2	109.6	58	58	49	62.2	381	23698
63	S	119.1	0.0	388	68.6	119.1	63	63	54	68.6	388	26617
68	S	128.5	0.0	374	74.9	128.5	68	68	59	74.9	374	28013
73	S	138.0	0.0	357	81.3	138.0	73	73	64	81.3	357	29024
78	S	147.4	0.0	308	88.9	147.4	78	78	70	88.9	308	27381
83	S	156.9	0.0	247	96.5	156.9	83	83	76	96.5	247	23836
88	S	166.3	0.0	171	104.1	166.3	88	88	82	104.1	171	17801
93	S	175.8	0.0	109	113.0	175.8	93	93	89	113.0	109	12317
98	S	185.2	0.0	59	121.9	185.2	98	98	96	121.9	59	7192
103	S	194.7	6.6	25	127.0	188.1	100	100	100	127.0	25	3175
108	S	204.1	16.0	7	127.0	188.1	100	100	100	127.0	7	889
113	S	213.6	25.5	2	127.0	188.1	100	100	100	127.0	2	254
118	S	223.0	34.9	0	127.0	188.1	100	100	100	127.0	0	0
				8602							4160	275936

PLANT NO:	29		MASTER CHILLER NO (LEAD):	43	
BUILDING NO:	50001				
DESIGN LOAD:	129	TONS	COMPRESSOR:	CENT	
WINTER LOAD:	20	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-123	
			STATUS:	NEW	
PEAK DEMAND:	87.2	KW			
CONSUMPTION:	288903	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$13,307	/YR	LOAD LIMIT:	100	%
ENERGY COST:	$6,934	/YR			
TOTAL COST:	$20,240	/YR	RATED CAPACITY:	129.2	TONS
			RATED POWER:	87.2	KW
UNIT OUTPUT COST:	$157	/TON*YR	RATED EFFICIENCY:	0.675	KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
20	W	25.8	0.0	4380	22.7	25.8	20	20	26	22.7	4380	99426
3	S	3.9	0.0	37	22.7	3.9	3	15	26	22.7	7	159
8	S	10.3	0.0	50	22.7	10.3	8	15	28	22.7	27	613
13	S	16.8	0.0	65	22.7	16.8	13	15	26	22.7	56	1271
18	S	23.2	0.0	83	22.7	23.2	18	18	26	22.7	83	1884
23	S	29.7	0.0	106	22.7	29.7	23	23	26	22.7	106	2406
28	S	36.1	0.0	143	22.7	36.1	28	28	26	22.7	143	3246
33	S	42.6	0.0	184	24.4	42.6	33	33	28	24.4	184	4490
38	S	49.0	0.0	232	27.9	49.0	38	38	32	27.9	232	6473
43	S	55.5	0.0	259	31.4	55.5	43	43	36	31.4	259	8133
48	S	61.9	0.0	292	34.9	61.9	48	48	40	34.9	292	10191
53	S	68.4	0.0	343	38.4	68.4	53	53	44	38.4	343	13171
58	S	74.8	0.0	381	42.7	74.8	58	58	49	42.7	381	16269
63	S	81.3	0.0	388	47.1	81.3	63	63	54	47.1	388	18275
68	S	87.7	0.0	374	51.4	87.7	68	68	59	51.4	374	19224
73	S	94.2	0.0	357	55.8	94.2	73	73	64	55.8	357	19921
78	S	100.6	0.0	308	61.0	100.6	78	78	70	61.0	308	18788
83	S	107.1	0.0	247	66.3	107.1	83	83	76	66.3	247	16376
88	S	113.5	0.0	171	71.5	113.5	88	88	82	71.5	171	12227
93	S	120.0	0.0	109	77.6	120.0	93	93	89	77.6	109	8458
98	S	126.4	0.0	59	83.7	126.4	98	98	96	83.7	59	4938
103	S	132.9	3.7	25	87.2	129.2	100	100	100	87.2	25	2180
108	S	139.3	10.1	7	87.2	129.2	100	100	100	87.2	7	610
113	S	145.8	16.6	2	87.2	129.2	100	100	100	87.2	2	174
118	S	152.2	23.0	0	87.2	129.2	100	100	100	87.2	0	0
				8602							8540	288903

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Table I-2. ECO-1 Calculation of Chiller Energy Cost for New Conditions

PLANT NO:	30		MASTER CHILLER NO (LEAD):	44	
BUILDING NO:	50004				
DESIGN LOAD:	306	TONS	COMPRESSOR:	CENT	
WINTER LOAD:	20	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-123	
			STATUS:	NEW	
PEAK DEMAND:	198.0	KW			
CONSUMPTION:	655812	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$30,215	/YR	LOAD LIMIT:	100	%
ENERGY COST:	$15,739	/YR			
TOTAL COST:	$45,954	/YR	RATED CAPACITY:	306.0	TONS
			RATED POWER:	198.0	KW
UNIT OUTPUT COST:	$150	/TON*YR	RATED EFFICIENCY:	0.647	KW/TON

% PLANT DSGN LOAD	PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%	TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
20 W	61.2	0.0	4380	51.5	61.2	20	20	26	51.5	4380	225570
3 S	9.2	0.0	37	51.5	9.2	3	15	26	51.5	7	361
8 S	24.5	0.0	50	51.5	24.5	8	15	26	51.5	27	1391
13 S	39.8	0.0	65	51.5	39.8	13	15	26	51.5	56	2884
18 S	55.1	0.0	83	51.5	55.1	18	18	26	51.5	83	4275
23 S	70.4	0.0	106	51.5	70.4	23	23	26	51.5	106	5459
28 S	85.7	0.0	143	51.5	85.7	28	28	26	51.5	143	7365
33 S	101.0	0.0	184	55.4	101.0	33	33	28	55.4	184	10194
38 S	116.3	0.0	232	63.4	116.3	38	38	32	63.4	232	14709
43 S	131.6	0.0	259	71.3	131.6	43	43	36	71.3	259	18467
48 S	146.9	0.0	292	79.2	146.9	48	48	40	79.2	292	23126
53 S	162.2	0.0	343	87.1	162.2	53	53	44	87.1	343	29875
58 S	177.5	0.0	381	97.0	177.5	58	58	49	97.0	381	36957
63 S	192.8	0.0	388	106.9	192.8	63	63	54	106.9	388	41477
68 S	208.1	0.0	374	116.8	208.1	68	68	59	116.8	374	43683
73 S	223.4	0.0	357	126.7	223.4	73	73	64	126.7	357	45232
78 S	238.7	0.0	308	138.6	238.7	78	78	70	138.6	308	42689
83 S	254.0	0.0	247	150.5	254.0	83	83	76	150.5	247	37174
88 S	269.3	0.0	171	162.4	269.3	88	88	82	162.4	171	27770
93 S	284.6	0.0	109	176.2	284.6	93	93	89	176.2	109	19206
98 S	299.9	0.0	59	190.1	299.9	98	98	96	190.1	59	11216
103 S	315.2	9.2	25	198.0	306.0	100	100	100	198.0	25	4950
108 S	330.5	24.5	7	198.0	306.0	100	100	100	198.0	7	1386
113 S	345.8	39.8	2	198.0	306.0	100	100	100	198.0	2	396
118 S	361.1	55.1	0	198.0	306.0	100	100	100	198.0	0	0
			8602							8540	655812

PLANT NO:	31		MASTER CHILLER NO (LEAD):	48		MASTER CHILLER NO (LAG 1):	47	
BUILDING NO:	87018							
DESIGN LOAD:	902	TONS	COMPRESSOR:	CENT		COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER		CONDENSER:	WATER	
SIMULATION MODEL:	EQ-2S		REFRIGERANT:	R-123		REFRIGERANT:	R-123	
			STATUS:	NEW		STATUS:	NEW	
PEAK DEMAND:	559.2	KW						
CONSUMPTION:	1152030	KWH/YR	CONFIGURATION:	SERIES/SINGLE		CONFIGURATION:	SERIES/SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	80	%	MIN LAG SETPOINT:	40	%
DEMAND COST:	$85,334	/YR	LOAD LIMIT:	100	%	LOAD LIMIT:	100	%
ENERGY COST:	$27,649	/YR						
TOTAL COST:	$112,983	/YR	RATED CAPACITY:	474.0	TONS	RATED CAPACITY:	474.0	TONS
			RATED POWER:	279.6	KW	RATED POWER:	279.6	KW
UNIT OUTPUT COST:	$119	/TON*YR	RATED EFFICIENCY:	0.590	KW/TON	RATED EFFICIENCY:	0.590	KW/TON

% PLANT DSGN LOAD	PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%	TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR	TONS	%	%	%	KW	HR/YR	KWH/YR
0 W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0	0.0	0	0	0	0.0	0	0
3 S	27.1	0.0	37	72.7	27.1	6	15	26	72.7	15	1091	0.0	0	0	0	0.0	0	0
8 S	72.2	0.0	50	72.7	72.2	15	15	26	72.7	50	3635	0.0	0	0	0	0.0	0	0
13 S	117.3	0.0	65	72.7	117.3	25	25	26	72.7	65	4726	0.0	0	0	0	0.0	0	0
18 S	162.4	0.0	83	81.1	162.4	34	34	29	81.1	83	6731	0.0	0	0	0	0.0	0	0
23 S	207.5	0.0	106	103.5	207.5	44	44	37	103.5	106	10971	0.0	0	0	0	0.0	0	0
28 S	252.6	0.0	143	123.0	252.6	53	53	44	123.0	143	17589	0.0	0	0	0	0.0	0	0
33 S	297.7	0.0	184	151.0	297.7	63	63	54	151.0	184	27784	0.0	0	0	0	0.0	0	0
38 S	342.8	0.0	232	176.1	342.8	72	72	63	176.1	232	40855	0.0	0	0	0	0.0	0	0
43 S	387.9	0.0	259	193.0	198.3	42	42	35	97.9	259	25356	189.6	40	40	34	95.1	259	24631
48 S	433.0	0.0	292	212.5	243.4	51	51	42	117.4	292	34281	189.6	40	40	34	95.1	292	27769
53 S	478.1	0.0	343	240.5	288.5	61	61	52	145.4	343	49872	189.6	40	40	34	95.1	343	32619
58 S	523.2	0.0	381	265.7	333.6	70	70	61	170.6	381	64999	189.6	40	40	34	95.1	381	36233
63 S	568.3	0.0	388	296.4	378.7	80	80	72	201.3	388	78104	189.6	40	40	34	95.1	388	36899
68 S	613.4	0.0	374	310.4	281.6	59	59	50	139.8	374	52285	331.8	70	70	61	170.6	374	63804
73 S	658.5	0.0	357	338.4	326.7	69	69	60	167.8	357	59905	331.8	70	70	61	170.6	357	60904
78 S	703.6	0.0	308	366.3	371.8	78	78	70	195.7	308	60276	331.8	70	70	61	170.6	308	52545
83 S	748.7	0.0	247	416.6	274.7	58	58	49	137.0	247	33839	474.0	100	100	100	279.6	247	69061
88 S	793.8	0.0	171	441.8	319.8	67	67	58	162.2	171	27736	474.0	100	100	100	279.6	171	47812
93 S	838.9	0.0	109	472.5	364.9	77	77	69	192.9	109	21026	474.0	100	100	100	279.6	109	30476
98 S	884.0	0.0	59	503.3	410.0	86	86	80	223.7	59	13198	474.0	100	100	100	279.6	59	16496
103 S	929.1	0.0	25	539.6	455.1	96	96	93	260.0	25	6500	474.0	100	100	100	279.6	25	6990
108 S	974.2	26.2	7	559.2	474.0	100	100	100	279.6	7	1957	474.0	100	100	100	279.6	7	1957
113 S	1019.3	71.3	2	559.2	474.0	100	100	100	279.6	2	559	474.0	100	100	100	279.6	2	559
118 S	1064.4	116.4	0	559.2	474.0	100	100	100	279.6	0	0	474.0	100	100	100	279.6	0	0
			8602							4200	643275						3322	508755

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Table I-2. ECO-1 Calculation of Chiller Energy Cost for New Conditions

PLANT NO:	32		MASTER CHILLER NO (LEAD):	49	
BUILDING NO:	91001				
DESIGN LOAD:	123	TONS	COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-123	
			STATUS:	NEW	
PEAK DEMAND:	83.3	KW			
CONSUMPTION:	183341	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$12,712	/YR	LOAD LIMIT:	100	%
ENERGY COST:	$4,400	/YR			
TOTAL COST:	$17,112	/YR	RATED CAPACITY:	121.8	TONS
			RATED POWER:	83.3	KW
UNIT OUTPUT COST:	$140	/TON*YR	RATED EFFICIENCY:	0.684	KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3	S	3.7	0.0	37	21.7	3.7	3	15	26	21.7	7	152
8	S	9.8	0.0	50	21.7	9.8	8	15	26	21.7	27	586
13	S	16.0	0.0	65	21.7	16.0	13	15	26	21.7	56	1215
18	S	22.1	0.0	83	21.7	22.1	18	18	26	21.7	83	1801
23	S	28.3	0.0	106	21.7	28.3	23	23	26	21.7	106	2300
28	S	34.4	0.0	143	21.7	34.4	28	28	26	21.7	143	3103
33	S	40.6	0.0	184	23.3	40.6	33	33	28	23.3	184	4287
38	S	46.7	0.0	232	26.7	46.7	38	38	32	26.7	232	6194
43	S	52.9	0.0	259	30.0	52.9	43	43	36	30.0	259	7770
48	S	59.0	0.0	292	33.3	59.0	48	48	40	33.3	292	9724
53	S	65.2	0.0	343	37.5	65.2	54	54	45	37.5	343	12863
58	S	71.3	0.0	381	41.7	71.3	59	59	50	41.7	381	15888
63	S	77.5	0.0	388	45.8	77.5	64	64	55	45.8	388	17770
68	S	83.6	0.0	374	50.0	83.6	69	69	60	50.0	374	18700
73	S	89.8	0.0	357	54.1	89.8	74	74	65	54.1	357	19314
78	S	95.9	0.0	308	59.1	95.9	79	79	71	59.1	308	18203
83	S	102.1	0.0	247	64.1	102.1	84	84	77	64.1	247	15833
88	S	108.2	0.0	171	69.1	108.2	89	89	83	69.1	171	11816
93	S	114.4	0.0	109	75.0	114.4	94	94	90	75.0	109	8175
98	S	120.5	0.0	59	81.6	120.5	99	99	98	81.6	59	4814
103	S	126.7	4.9	25	83.3	121.8	100	100	100	83.3	25	2083
108	S	132.8	11.0	7	83.3	121.8	100	100	100	83.3	7	583
113	S	139.0	17.2	2	83.3	121.8	100	100	100	83.3	2	167
118	S	145.1	23.3	0	83.3	121.8	100	100	100	83.3	0	0
				8602							4160	183341

APPENDIX I

Table I-3. ECO-1 Calculation of Revised Chiller Energy Cost with Load Limits

PLANT NO:	5	
BUILDING NO:	410	
DESIGN LOAD:	238	TONS
WINTER LOAD:	0	%DSGN
SIMULATION MODEL:	EQ-2H	
PEAK DEMAND:	144.2	KW
CONSUMPTION:	350796	KWH/YR
DEMAND COST:	$22,005	/YR
ENERGY COST:	$8,419	/YR
TOTAL COST:	$30,424	/YR
UNIT OUTPUT COST:	$139	/TON*YR

MASTER CHILLER NO (LEAD):	6	
COMPRESSOR:	CENT	
CONDENSER:	WATER	
REFRIGERANT:	R-123	
STATUS:	NEW W/ LOAD LIMIT	
CONFIGURATION:	PARALLEL	
MAX LEAD SETPT or PRO-RATE LOAD:	80	%
LOAD LIMIT:	92	%
RATED CAPACITY:	119.0	TONS
RATED POWER:	81.9	KW
RATED EFFICIENCY:	0.688	KW/TON

MASTER CHILLER NO (LAG 1):	7	
COMPRESSOR:	CENT	
CONDENSER:	WATER	
REFRIGERANT:	R-123	
STATUS:	NEW W/ LOAD LIMIT	
CONFIGURATION:	PARALLEL	
MIN LAG SETPOINT:	NA	%
LOAD LIMIT:	92	%
RATED CAPACITY:	119.0	TONS
RATED POWER:	81.9	KW
RATED EFFICIENCY:	0.688	KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR	TONS	%	%	%	KW	HR/YR	KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0	0.0	0	0	0	0.0	0	0
3	S	7.1	0.0	37	21.3	7.1	6	15	26	21.3	15	320	0.0	0	0	0	0.0	0	0
8	S	19.0	0.0	50	21.3	19.0	16	16	26	21.3	50	1065	0.0	0	0	0	0.0	0	0
13	S	30.9	0.0	65	21.3	30.9	26	26	26	21.3	65	1385	0.0	0	0	0	0.0	0	0
18	S	42.8	0.0	83	24.6	42.8	36	36	30	24.6	83	2042	0.0	0	0	0	0.0	0	0
23	S	54.7	0.0	106	31.1	54.7	46	46	38	31.1	106	3297	0.0	0	0	0	0.0	0	0
28	S	66.6	0.0	143	38.5	66.6	56	56	47	38.5	143	5506	0.0	0	0	0	0.0	0	0
33	S	78.5	0.0	184	46.7	78.5	66	66	57	46.7	184	8593	0.0	0	0	0	0.0	0	0
38	S	90.4	0.0	232	55.7	90.4	76	76	68	55.7	232	12922	0.0	0	0	0	0.0	0	0
43	S	102.3	0.0	259	59.0	51.2	43	43	36	29.5	259	7641	51.1	43	43	36	29.5	259	7641
48	S	114.2	0.0	292	65.6	57.1	48	48	40	32.8	292	9578	57.1	48	48	40	32.8	292	9578
53	S	126.1	0.0	343	72.0	63.1	53	53	44	36.0	343	12348	63.0	53	53	44	36.0	343	12348
58	S	138.0	0.0	381	80.2	69.0	58	58	49	40.1	381	15278	69.0	58	58	49	40.1	381	15278
63	S	149.9	0.0	388	88.4	75.0	63	63	54	44.2	388	17150	74.9	63	63	54	44.2	388	17150
68	S	161.8	0.0	374	96.6	80.9	68	68	59	48.3	374	18064	80.9	68	68	59	48.3	374	18064
73	S	173.7	0.0	357	104.8	86.9	73	73	64	52.4	357	18707	86.8	73	73	64	52.4	357	18707
78	S	185.6	0.0	308	114.6	92.8	78	78	70	57.3	308	17648	92.8	78	78	70	57.3	308	17648
83	S	197.5	0.0	247	124.4	98.8	83	83	76	62.2	247	15363	98.7	83	83	76	62.2	247	15363
88	S	209.4	0.0	171	134.4	104.7	88	88	82	67.2	171	11491	104.7	88	88	82	67.2	171	11491
93	S	221.3	2.3	109	144.2	109.5	92	92	88	72.1	109	7859	109.5	92	92	88	72.1	109	7859
98	S	233.2	14.2	59	144.2	109.5	92	92	88	72.1	59	4254	109.5	92	92	88	72.1	59	4254
103	S	245.1	26.1	25	144.2	109.5	92	92	88	72.1	25	1803	109.5	92	92	88	72.1	25	1803
108	S	257.0	38.0	7	144.2	109.5	92	92	88	72.1	7	505	109.5	92	92	88	72.1	7	505
113	S	268.9	49.9	2	144.2	109.5	92	92	88	72.1	2	144	109.5	92	92	88	72.1	2	144
118	S	280.8	61.8	0	144.2	109.5	92	92	88	72.1	0	0	109.5	92	92	88	72.1	0	0
				8602							4200	192963						3322	157833

PLANT NO:	13	
BUILDING NO:	14020	
DESIGN LOAD:	154	TONS
WINTER LOAD:	0	%DSGN
SIMULATION MODEL:	EQ-1	
PEAK DEMAND:	86.9	KW
CONSUMPTION:	218071	KWH/YR
DEMAND COST:	$13,261	/YR
ENERGY COST:	$5,234	/YR
TOTAL COST:	$18,495	/YR
UNIT OUTPUT COST:	$132	/TON*YR

MASTER CHILLER NO (LEAD):	20	
COMPRESSOR:	CENT	
CONDENSER:	WATER	
REFRIGERANT:	R-123	
STATUS:	NEW W/ LOAD LIMIT	
CONFIGURATION:	SINGLE	
MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
LOAD LIMIT:	91	%
RATED CAPACITY:	154.0	TONS
RATED POWER:	101.0	KW
RATED EFFICIENCY:	0.656	KW/TON

% PLANT DSGN LOAD		PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%		TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3	S	4.6	0.0	37	26.3	4.6	3	15	26	26.3	7	184
8	S	12.3	0.0	50	26.3	12.3	8	15	26	26.3	27	710
13	S	20.0	0.0	65	26.3	20.0	13	15	26	26.3	56	1473
18	S	27.7	0.0	83	26.3	27.7	18	18	26	26.3	83	2183
23	S	35.4	0.0	106	26.3	35.4	23	23	26	26.3	106	2788
28	S	43.1	0.0	143	26.3	43.1	28	28	26	26.3	143	3761
33	S	50.8	0.0	184	28.3	50.8	33	33	28	28.3	184	5207
38	S	58.5	0.0	232	32.3	58.5	38	38	32	32.3	232	7494
43	S	66.2	0.0	259	36.4	66.2	43	43	36	36.4	259	9428
48	S	73.9	0.0	292	40.4	73.9	48	48	40	40.4	292	11797
53	S	81.6	0.0	343	44.4	81.6	53	53	44	44.4	343	15229
58	S	89.3	0.0	381	49.5	89.3	58	58	49	49.5	381	18860
63	S	97.0	0.0	388	54.5	97.0	63	63	54	54.5	388	21146
68	S	104.7	0.0	374	59.6	104.7	68	68	59	59.6	374	22290
73	S	112.4	0.0	357	64.6	112.4	73	73	64	64.6	357	23062
78	S	120.1	0.0	308	70.7	120.1	78	78	70	70.7	308	21776
83	S	127.8	0.0	247	76.8	127.8	83	83	76	76.8	247	18970
88	S	135.5	0.0	171	82.8	135.5	88	88	82	82.8	171	14159
93	S	143.2	3.1	109	86.9	140.1	91	91	86	86.9	109	9472
98	S	150.9	10.8	59	86.9	140.1	91	91	86	86.9	59	5127
103	S	158.6	18.5	25	86.9	140.1	91	91	86	86.9	25	2173
108	S	166.3	26.2	7	86.9	140.1	91	91	86	86.9	7	608
113	S	174.0	33.9	2	86.9	140.1	91	91	86	86.9	2	174
118	S	181.7	41.6	0	86.9	140.1	91	91	86	86.9	0	0
				8602							4160	218071

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Table I-3. ECO-1 Calculation of Revised Chiller Energy Cost with Load Limits

PLANT NO:	14		MASTER CHILLER NO (LEAD):	21	
BUILDING NO:	14023				
DESIGN LOAD:	166	TONS	COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-123	
			STATUS:	NEW W/ LOAD LIMIT	
PEAK DEMAND:	90.4	KW			
CONSUMPTION:	237087	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$13,795	/YR	LOAD LIMIT:	88	%
ENERGY COST:	$5,690	/YR			
TOTAL COST:	$19,485	/YR	RATED CAPACITY:	166.0	TONS
			RATED POWER:	110.2	KW
UNIT OUTPUT COST:	$133	/TON*YR	RATED EFFICIENCY:	0.664	KW/TON

% PLANT DSGN LOAD %		PLANT LOAD TONS	PLANT LOAD SHED TONS	ANNUAL OCCUR ACTUAL HR/YR	PLANT DEMAND KW	CHIL LOAD TONS	% RAT CAP ACT %	% RAT CAP ADJ %	% RAT POW %	POWER KW	ANNUAL OCCUR ADJUST HR/YR	ANNUAL ENERGY CONSUMP KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3	S	5.0	0.0	37	28.7	5.0	3	15	26	28.7	7	201
8	S	13.3	0.0	50	28.7	13.3	8	15	26	28.7	27	775
13	S	21.6	0.0	65	28.7	21.6	13	15	26	28.7	56	1607
18	S	29.9	0.0	83	28.7	29.9	18	18	26	28.7	83	2382
23	S	38.2	0.0	106	28.7	38.2	23	23	26	28.7	106	3042
28	S	46.5	0.0	143	28.7	46.5	28	28	26	28.7	143	4104
33	S	54.8	0.0	184	30.9	54.8	33	33	28	30.9	184	5686
38	S	63.1	0.0	232	35.3	63.1	38	38	32	35.3	232	8190
43	S	71.4	0.0	259	39.7	71.4	43	43	36	39.7	259	10282
48	S	79.7	0.0	292	44.1	79.7	48	48	40	44.1	292	12877
53	S	88.0	0.0	343	48.5	88.0	53	53	44	48.5	343	16636
58	S	96.3	0.0	381	54.0	96.3	58	58	49	54.0	381	20574
63	S	104.6	0.0	388	59.5	104.6	63	63	54	59.5	388	23086
68	S	112.9	0.0	374	65.0	112.9	68	68	59	65.0	374	24310
73	S	121.2	0.0	357	70.5	121.2	73	73	64	70.5	357	25169
78	S	129.5	0.0	308	77.1	129.5	78	78	70	77.1	308	23747
83	S	137.8	0.0	247	83.8	137.8	83	83	76	83.8	247	20699
88	S	146.1	0.0	171	90.4	146.1	88	88	82	90.4	171	15458
93	S	154.4	8.3	109	90.4	146.1	88	88	82	90.4	109	9854
98	S	162.7	16.6	59	90.4	146.1	88	88	82	90.4	59	5334
103	S	171.0	24.9	25	90.4	146.1	88	88	82	90.4	25	2260
108	S	179.3	33.2	7	90.4	146.1	88	88	82	90.4	7	633
113	S	187.8	41.5	2	90.4	146.1	88	88	82	90.4	2	181
118	S	195.9	49.8	0	90.4	146.1	88	88	82	90.4	0	0
				8802							4160	237087

PLANT NO:	15		MASTER CHILLER NO (LEAD):	22	
BUILDING NO:	21002				
DESIGN LOAD:	240	TONS	COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-123	
			STATUS:	NEW W/ LOAD LIMIT	
PEAK DEMAND:	144.0	KW			
CONSUMPTION:	365360	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$21,974	/YR	LOAD LIMIT:	90	%
ENERGY COST:	$8,769	/YR			
TOTAL COST:	$30,743	/YR	RATED CAPACITY:	240.0	TONS
			RATED POWER:	169.4	KW
UNIT OUTPUT COST:	$142	/TON*YR	RATED EFFICIENCY:	0.708	KW/TON

% PLANT DSGN LOAD %		PLANT LOAD TONS	PLANT LOAD SHED TONS	ANNUAL OCCUR ACTUAL HR/YR	PLANT DEMAND KW	CHIL LOAD TONS	% RAT CAP ACT %	% RAT CAP ADJ %	% RAT POW %	POWER KW	ANNUAL OCCUR ADJUST HR/YR	ANNUAL ENERGY CONSUMP KWH/YR
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3	S	7.2	0.0	37	44.0	7.2	3	15	26	44.0	7	308
8	S	19.2	0.0	50	44.0	19.2	8	15	26	44.0	27	1188
13	S	31.2	0.0	65	44.0	31.2	13	15	26	44.0	56	2464
18	S	43.2	0.0	83	44.0	43.2	18	18	26	44.0	83	3652
23	S	55.2	0.0	106	44.0	55.2	23	23	26	44.0	106	4664
28	S	67.2	0.0	143	44.0	67.2	28	28	26	44.0	143	6292
33	S	79.2	0.0	184	47.4	79.2	33	33	28	47.4	184	8722
38	S	91.2	0.0	232	54.2	91.2	38	38	32	54.2	232	12574
43	S	103.2	0.0	259	61.0	103.2	43	43	36	61.0	259	15799
48	S	115.2	0.0	292	67.8	115.2	48	48	40	67.8	292	19798
53	S	127.2	0.0	343	74.5	127.2	53	53	44	74.5	343	25554
58	S	139.2	0.0	381	83.0	139.2	58	58	49	83.0	381	31623
63	S	151.2	0.0	388	91.5	151.2	63	63	54	91.5	388	35502
68	S	163.2	0.0	374	99.9	163.2	68	68	59	99.9	374	37363
73	S	175.2	0.0	357	108.4	175.2	73	73	64	108.4	357	38699
78	S	187.2	0.0	308	118.6	187.2	78	78	70	118.6	308	36529
83	S	199.2	0.0	247	128.7	199.2	83	83	76	128.7	247	31789
88	S	211.2	0.0	171	138.9	211.2	88	88	82	138.9	171	23752
93	S	223.2	7.2	109	144.0	216.0	90	90	85	144.0	109	15696
98	S	235.2	19.2	59	144.0	216.0	90	90	85	144.0	59	8496
103	S	247.2	31.2	25	144.0	216.0	90	90	85	144.0	25	3600
108	S	259.2	43.2	7	144.0	216.0	90	90	85	144.0	7	1008
113	S	271.2	55.2	2	144.0	216.0	90	90	85	144.0	2	288
118	S	283.2	67.2	0	144.0	216.0	90	90	85	144.0	0	0
				8602							4160	365360

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Table I-3. ECO-1 Calculation of Revised Chiller Energy Cost with Load Limits

PLANT NO:	17	
BUILDING NO:	28000	
DESIGN LOAD:	238	TONS
WINTER LOAD:	0	%DSGN
SIMULATION MODEL:	EQ-2M	
PEAK DEMAND:	144.2	KW
CONSUMPTION:	350796	KWH/YR
DEMAND COST:	$22,005	/YR
ENERGY COST:	$8,419	/YR
TOTAL COST:	$30,424	/YR
UNIT OUTPUT COST:	$139	/TON*YR

MASTER CHILLER NO (LEAD):	24	
COMPRESSOR:	CENT	
CONDENSER:	WATER	
REFRIGERANT:	R-123	
STATUS:	NEW W/ LOAD LIMIT	
CONFIGURATION:	PARALLEL	
MAX LEAD SETPT or PRO-RATE LOAD:	80	%
LOAD LIMIT:	92	%
RATED CAPACITY:	119.0	TONS
RATED POWER:	81.9	KW
RATED EFFICIENCY:	0.688	KW/TON

MASTER CHILLER NO (LAG 1):	25	
COMPRESSOR:	CENT	
CONDENSER:	WATER	
REFRIGERANT:	R-123	
STATUS:	NEW W/ LOAD LIMIT	
CONFIGURATION:	PARALLEL	
MIN LAG SETPOINT:	NA	%
LOAD LIMIT:	92	%
RATED CAPACITY:	119.0	TONS
RATED POWER:	81.9	KW
RATED EFFICIENCY:	0.688	KW/TON

% PLANT DSGN LOAD (%)		PLANT LOAD (TONS)	PLANT LOAD SHED (TONS)	ANNUAL OCCUR ACTUAL (HR/YR)	PLANT DEMAND (KW)	CHIL LOAD (TONS)	% RAT CAP ACT (%)	% RAT CAP ADJ (%)	% RAT POW (%)	POWER (KW)	ANNUAL OCCUR ADJUST (HR/YR)	ANNUAL ENERGY CONSUMP (KWH/YR)
0	W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3	S	7.1	0.0	37	21.3	7.1	8	15	26	21.3	15	320
8	S	19.0	0.0	50	21.3	19.0	16	16	26	21.3	50	1065
13	S	30.9	0.0	65	21.3	30.9	26	26	26	21.3	65	1385
18	S	42.8	0.0	83	24.6	42.8	36	36	30	24.6	83	2042
23	S	54.7	0.0	106	31.1	54.7	46	46	38	31.1	106	3297
28	S	66.6	0.0	143	38.5	66.6	56	56	47	38.5	143	5506
33	S	78.5	0.0	184	46.7	78.5	66	66	57	46.7	184	8593
38	S	90.4	0.0	232	55.7	90.4	76	76	68	55.7	232	12922
43	S	102.3	0.0	259	59.0	51.2	43	43	36	29.5	259	7641
48	S	114.2	0.0	292	65.8	57.1	48	48	40	32.8	292	9578
53	S	126.1	0.0	343	72.0	63.1	53	53	44	36.0	343	12348
58	S	138.0	0.0	381	80.2	69.0	58	58	49	40.1	381	15278
63	S	149.9	0.0	388	88.4	75.0	63	63	54	44.2	388	17150
68	S	161.8	0.0	374	96.6	80.9	68	68	59	48.3	374	18064
73	S	173.7	0.0	357	104.8	86.9	73	73	64	52.4	357	18707
78	S	185.6	0.0	308	114.6	92.8	78	78	70	57.3	308	17648
83	S	197.5	0.0	247	124.4	98.8	83	83	76	62.2	247	15363
88	S	209.4	0.0	171	134.4	104.7	88	88	82	67.2	171	11491
93	S	221.3	2.3	109	144.2	109.5	92	92	88	72.1	109	7859
98	S	233.2	14.2	59	144.2	109.5	92	92	88	72.1	59	4254
103	S	245.1	26.1	25	144.2	109.5	92	92	88	72.1	25	1803
108	S	257.0	38.0	7	144.2	109.5	92	92	88	72.1	7	505
113	S	268.9	49.9	2	144.2	109.5	92	92	88	72.1	2	144
118	S	280.8	61.8	0	144.2	109.5	92	92	88	72.1	0	0
				8602							4200	192963

% PLANT DSGN LOAD (%)		CHIL LOAD (TONS)	% RAT CAP ACT (%)	% RAT CAP ADJ (%)	% RAT POW (%)	POWER (KW)	ANNUAL OCCUR ADJUST (HR/YR)	ANNUAL ENERGY CONSUMP (KWH/YR)
0	W	0.0	0	0	0	0.0	0	0
3	S	0.0	0	0	0	0.0	0	0
8	S	0.0	0	0	0	0.0	0	0
13	S	0.0	0	0	0	0.0	0	0
18	S	0.0	0	0	0	0.0	0	0
23	S	0.0	0	0	0	0.0	0	0
28	S	0.0	0	0	0	0.0	0	0
33	S	0.0	0	0	0	0.0	0	0
38	S	0.0	0	0	0	0.0	0	0
43	S	51.1	43	43	36	29.5	259	7641
48	S	57.1	48	48	40	32.8	292	9578
53	S	63.0	53	53	44	36.0	343	12348
58	S	69.0	58	58	49	40.1	381	15278
63	S	74.9	63	63	54	44.2	388	17150
68	S	80.9	68	68	59	48.3	374	18064
73	S	86.8	73	73	64	52.4	357	18707
78	S	92.8	78	78	70	57.3	308	17648
83	S	98.7	83	83	76	62.2	247	15363
88	S	104.7	88	88	82	67.2	171	11491
93	S	109.5	92	92	88	72.1	109	7859
98	S	109.5	92	92	88	72.1	59	4254
103	S	109.5	92	92	88	72.1	25	1803
108	S	109.5	92	92	88	72.1	7	505
113	S	109.5	92	92	88	72.1	2	144
118	S	109.5	92	92	88	72.1	0	0
							3322	157833

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Table I-4. ECO-1 Calculation of Construction Cost

PLANT BLDG NO	MASTER CHILLER NO	ITEM	QTY PER CHIL or 1-WAY RUN	QTY ADJUST FACTOR	LABOR DIFFIC ADJUST FACTOR	UNIT	UNIT BARE (TOT) MTL COST $/UNIT	UNIT BARE (TOT) LAB COST $/UNIT	UNIT BARE (TOT) EQP COST $/UNIT	MTL MARK UP %	LAB OH&P %	EQP MARK UP %	MTL COST ADJUST (AUSTIN) %	LAB COST ADJUST (AUSTIN) %	MTL COST $	LAB COST $	EQP COST $	TOTAL COST $
121	1	REPLACE (DOWNSIZE) CHILLER																
		CHILLER - CENTRIFUGAL, WATER-COOLED	138.0	1	1.00	TONS	382)(	127)(	0)	-	-	-	-	-	52716	17526	0	70242
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 6"	10	2	1.00	LF	2.25	3.52	-	1.10	1.61	1.10	100.0	70.5	50	80	0	130
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		START/DISCON, WYE-DELTA, OPEN, NEMA TYPE 1	123	1	1.00	HP	29.16	5.21	-	1.10	1.51	1.10	102.4	67.8	4040	656	0	4696
		MOTOR CONNECTION W/ FLEX CONDUIT, 125 HP	1	2	1.00	EA	30.00	107.00	-	1.10	1.50	1.10	102.4	67.8	68	218	0	286
		WIRE, TYPE THWN, COPPER, STRANDED, 2/0	70	4	1.00	LF	1.32	0.74	-	1.10	1.51	1.10	102.4	67.8	416	211	0	627
		CONDUIT, RIGID GALV STL, 2"	70	1	1.00	LF	4.00	4.75	-	1.10	1.51	1.10	102.4	67.8	315	340	0	655
		DEMOLITION, CHILLER/PIPING/STARTER/CONDUIT	200.0	0.40	1.00	TONS	- (	117)	-	-	-	-	-	-	0	9360	0	9360
		SUBTOTAL													61797	32073	220	94090
		CONTINGENCY					15 %	15 %	15 %						9270	4811	33	14114
121	1	TOTAL													71067	36884	253	108204
121	1	ADDTL COST (PIPING) TO RELOCATE CHILLER																
		PIPE, STL, SCH 40, WELD, 6"	25	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	1018	1011	78	2107
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 6"	25	2	1.00	LF	2.25	3.52	-	1.10	1.61	1.10	100.0	70.5	124	200	0	324
		PIPE, STL, SCH 40, WELD, 6"	20	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	814	809	62	1685
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		SUBTOTAL													2316	3174	230	5720
		CONTINGENCY					15 %	15 %	15 %						347	476	35	858
121	1	TOTAL													2663	3650	265	6578
135	2	REPLACE (COMBINE/DOWNSIZE) CHILLER(S)																
		CHILLER - RECIPROCATING, WATER-COOLED	91.0	1	1.00	TONS	240)(	77)(	5)	-	-	-	-	-	21840	7007	455	29302
		PIPE, STL, SCH 40, WELD, 4"	10	2	1.00	LF	9.45	11.00	1.38	1.10	1.65	1.10	100.0	70.5	208	256	30	494
		ELBOW, STL, STD WGHT, WELD, 4"	2	2	1.00	EA	17.15	81.50	10.25	1.10	1.66	1.10	100.0	70.5	75	382	45	502
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 4"	1	2	1.00	EA	360.00	51.00	-	1.10	1.55	1.10	100.0	70.5	792	111	0	903
		FLANGE, STL, 150 LB, WELD NECK, 4"	3	2	1.00	EA	24.00	41.00	5.10	1.10	1.65	1.10	100.0	70.5	158	286	34	478
		VALVE, IRON, BUTTERFLY, LUG, 4"	1	2	1.00	EA	92.00	81.50	-	1.10	1.52	1.10	100.0	70.5	202	175	0	377
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 4"	10	2	1.00	LF	1.95	2.77	-	1.10	1.61	1.10	100.0	70.5	43	63	0	106
		PIPE, STL, SCH 40, WELD, 4"	10	2	1.00	LF	9.45	11.00	1.38	1.10	1.65	1.10	100.0	70.5	208	256	30	494
		ELBOW, STL, STD WGHT, WELD, 4"	2	2	1.00	EA	17.15	81.50	10.25	1.10	1.66	1.10	100.0	70.5	75	382	45	502
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 4"	1	2	1.00	EA	360.00	51.00	-	1.10	1.55	1.10	100.0	70.5	792	111	0	903
		FLANGE, STL, 150 LB, WELD NECK, 4"	3	2	1.00	EA	24.00	41.00	5.10	1.10	1.65	1.10	100.0	70.5	158	286	34	478
		VALVE, IRON, BUTTERFLY, LUG, 4"	1	2	1.00	EA	92.00	81.50	-	1.10	1.52	1.10	100.0	70.5	202	175	0	377
		START/DISCON, WYE-DELTA, OPEN, NEMA TYPE 1	103	1	1.00	HP	28.84	5.95	-	1.10	1.51	1.10	102.4	67.8	3346	627	0	3973
		MOTOR CONNECTION W/ FLEX CONDUIT, 125 HP	1	2	1.00	EA	30.00	107.00	-	1.10	1.50	1.10	102.4	67.8	68	218	0	286
		WIRE, TYPE THWN, COPPER, STRANDED, 1/0	70	4	1.00	LF	1.14	0.65	-	1.10	1.50	1.10	102.4	67.8	360	184	0	544
		CONDUIT, RIGID GALV STL, 1-1/2"	70	1	1.00	LF	3.15	3.88	-	1.10	1.50	1.10	102.4	67.8	248	276	0	524
		DEMOLITION, CHILLER/PIPING/STARTER/CONDUIT	73.5	0.40	1.00	TONS	- (	77)	-	-	-	-	-	-	0	2264	0	2264
		SUBTOTAL													28775	13059	673	42507
		CONTINGENCY					15 %	15 %	15 %						4316	1959	101	6376
135	2	TOTAL													33091	15018	774	48883

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Table I-4. ECO-1 Calculation of Construction Cost

PLANT BLDG NO	MASTER CHILLER NO	ITEM	QTY PER CHIL or 1-WAY RUN	QTY ADJUST FACTOR	LABOR DIFFIC ADJUST FACTOR	UNIT	UNIT BARE (TOT) MTL COST $/UNIT	UNIT BARE (TOT) LAB COST $/UNIT	UNIT BARE (TOT) EQP COST $/UNIT	MTL MARK UP %	LAB OH&P %	EQP MARK UP %	MTL COST ADJUST (AUSTIN) %	LAB COST ADJUST (AUSTIN) %	MTL COST $	LAB COST $	EQP COST $	TOTAL COST $
135	2	ADDTL COST (EQUIP) TO REPLACE (COMB/DOWNSIZE) COOL TOWER(S)																
		COOLING TOWER - OPEN, AXIAL FAN	91.0	1	1.00	TONS	59)(	7)	-	-	-	-	-	-	5369	637	0	6006
		CONCRETE FOUNDATION SUPPORT, 12"W x 36"H	9	2	1.00	LF	15.11	9.11	0.37	1.10	1.64	1.10	75.5	71.4	226	192	7	425
		CRANE, TRUCK MOUNTED, 12 TON	1	1	1.00	LIFT	-	-	-	-	-	-	-	-	-	125	400	525
		PIPE, STL, SCH 40, WELD, 4"	20	2	1.00	LF	9.45	11.00	1.38	1.10	1.65	1.10	100.0	70.5	416	512	61	989
		ELBOW, STL, STD WGHT, WELD, 4"	4	2	1.00	EA	17.15	81.50	10.25	1.10	1.66	1.10	100.0	70.5	151	763	90	1004
		FLANGE, STL, 150 LB, WELD NECK, 4"	3	2	1.00	EA	24.00	41.00	5.10	1.10	1.65	1.10	100.0	70.5	158	286	34	478
		VALVE, IRON, BUTTERFLY, LUG, 4"	1	2	1.00	EA	92.00	81.50	-	1.10	1.52	1.10	100.0	70.5	202	175	0	377
		DISCONNECT SWITCH, NEMA 4, 460 V, 30 A (THRU 15 HP)	2	1	1.00	EA	115.00	69.00	-	1.10	1.50	1.10	102.4	67.8	259	140	0	399
		MOTOR STARTER, NEMA 1, 460 V, NEMA 00 (THRU 2 HP)	2	1	1.00	EA	117.00	61.00	-	1.10	1.51	1.10	102.4	67.8	264	125	0	389
		MOTOR CONNECTION W/ FLEX CONDUIT, 5 HP	2	1	1.00	EA	3.55	26.50	-	1.10	1.51	1.10	102.4	67.8	8	54	0	62
		WIRE, TYPE THWN, COPPER, STRANDED, #14 (THRU 5 HP)	100	4	1.00	LF	0.05	0.16	-	1.10	1.48	1.10	102.4	67.8	23	66	0	89
		CONDUIT, RIGID GALV STL, 1/2" (THRU 4-#10)	100	1	1.00	LF	1.20	2.37	-	1.10	1.50	1.10	102.4	67.8	135	241	0	376
		DEMOLITION, COOLING TOWER/PIPING/STARTER/CONDUIT	73.5	1.00	1.00	TONS	- (	7)	-	-	-	-	-	-	0	515	0	515
		SUBTOTAL													7211	3831	592	11634
		CONTINGENCY					15 %	15 %	15 %						1082	575	89	1746
135	2	TOTAL													8293	4406	681	13380
135	2	ADDTL COST (EQUIP) TO ADD PRIMARY CHILLED WATER PUMP																
		PUMP, END SUCTION, 218 GPM @ 20', 3 HP	1	1	1.00	EA	955.00	204.00	-	1.10	1.47	1.10	100.0	70.5	1051	211	0	1262
		PIPE, STL, SCH 40, WELD, 4"	10	2	1.00	LF	9.45	11.00	1.38	1.10	1.65	1.10	100.0	70.5	208	256	30	494
		ELBOW, STL, STD WGHT, WELD, 4"	2	2	1.00	EA	17.15	81.50	10.25	1.10	1.66	1.10	100.0	70.5	75	382	45	502
		REDUCER, STL, STD WGHT, WELD, 4"	1	2	1.00	EA	17.20	68.00	8.55	1.10	1.66	1.10	100.0	70.5	38	159	19	216
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 4"	1	2	1.00	EA	360.00	51.00	-	1.10	1.55	1.10	100.0	70.5	792	111	0	903
		FLANGE, STL, 150 LB, WELD NECK, 4"	4	2	1.00	EA	24.00	41.00	5.10	1.10	1.65	1.10	100.0	70.5	211	382	45	638
		VALVE, IRON, BUTTERFLY, LUG, 4"	1	2	1.00	EA	92.00	81.50	-	1.10	1.52	1.10	100.0	70.5	202	175	0	377
		VALVE, IRON, SILENT CHECK, FLANGED, 150 LB, 4"	1	1	1.00	EA	256.00	81.50	-	1.10	1.51	1.10	100.0	70.5	282	87	0	369
		STRAINER, IRON, Y-TYPE, FLANGED, 125 LB, 4"	1	1	1.00	EA	172.00	136.00	-	1.10	1.51	1.10	100.0	70.5	189	145	0	334
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 4"	10	2	1.00	LF	1.95	2.77	-	1.10	1.61	1.10	100.0	70.5	43	63	0	106
		DISCONNECT SWITCH, NEMA 4, 460 V, 30 A (THRU 15 HP)	1	1	1.00	EA	115.00	69.00	-	1.10	1.50	1.10	102.4	67.8	130	70	0	200
		MOTOR STARTER, NEMA 1, 460 V, NEMA 0 (THRU 5 HP)	1	1	1.00	EA	145.00	93.00	-	1.10	1.50	1.10	102.4	67.8	163	95	0	258
		MOTOR CONNECTION W/ FLEX CONDUIT, 5 HP	1	1	1.00	EA	3.55	26.50	-	1.10	1.51	1.10	102.4	67.8	4	27	0	31
		WIRE, TYPE THWN, COPPER, STRANDED, #14 (THRU 5 HP)	50	4	1.00	LF	0.05	0.16	-	1.10	1.48	1.10	102.4	67.8	11	33	0	44
		CONDUIT, RIGID GALV STL, 1/2" (THRU 4-#10)	50	1	1.00	LF	1.20	2.37	-	1.10	1.50	1.10	102.4	67.8	68	121	0	189
		SUBTOTAL													3467	2317	139	5923
		CONTINGENCY					15 %	15 %	15 %						520	348	21	889
135	2	TOTAL													3987	2665	160	6812

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Table I-4. ECO-1 Calculation of Construction Cost

PLANT BLDG NO	MASTER CHILLER NO	ITEM	QTY PER CHIL or 1-WAY RUN	QTY ADJUST FACTOR	LABOR DIFFIC ADJUST FACTOR	UNIT	UNIT BARE (TOT) MTL COST $/UNIT	UNIT BARE (TOT) LAB COST $/UNIT	UNIT BARE (TOT) EQP COST $/UNIT	MTL MARK UP %	LAB OH&P %	EQP MARK UP %	MTL COST ADJUST (AUSTIN) %	LAB COST ADJUST (AUSTIN) %	MTL COST $	LAB COST $	EQP COST $	TOTAL COST $
135	2	ADDTL COST (EQUIP) TO REPLACE (COMB/DOWNSIZE) COND WATER PUMP(S)																
		PUMP, END SUCTION, 262 GPM @ 25', 5 HP	1	1	1.00	EA	1150.00	226.00	-	1.10	1.48	1.10	100.0	70.5	1265	236	0	1501
		PIPE, STL, SCH 40, WELD, 4"	10	2	1.00	LF	9.45	11.00	1.38	1.10	1.65	1.10	100.0	70.5	208	256	30	494
		ELBOW, STL, STD WGHT, WELD, 4"	2	2	1.00	EA	17.15	81.50	10.25	1.10	1.66	1.10	100.0	70.5	75	382	45	502
		REDUCER, STL, STD WGHT, WELD, 4"	1	2	1.00	EA	17.20	68.00	8.55	1.10	1.66	1.10	100.0	70.5	38	159	19	216
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 4"	1	2	1.00	EA	360.00	51.00	-	1.10	1.55	1.10	100.0	70.5	792	111	0	903
		FLANGE, STL, 150 LB, WELD NECK, 4"	4	2	1.00	EA	24.00	41.00	5.10	1.10	1.65	1.10	100.0	70.5	211	382	45	638
		VALVE, IRON, BUTTERFLY, LUG, 4"	1	2	1.00	EA	92.00	81.50	-	1.10	1.52	1.10	100.0	70.5	202	175	0	377
		VALVE, IRON, SILENT CHECK, FLANGED, 150 LB, 4"	1	1	1.00	EA	256.00	81.50	-	1.10	1.51	1.10	100.0	70.5	282	87	0	369
		STRAINER, IRON, Y-TYPE, FLANGED, 125 LB, 4"	1	1	1.00	EA	172.00	136.00	-	1.10	1.51	1.10	100.0	70.5	189	145	0	334
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 4"	10	2	1.00	LF	1.95	2.77	-	1.10	1.61	1.10	100.0	70.5	43	63	0	106
		DISCONNECT SWITCH, NEMA 4, 460 V, 30 A (THRU 15 HP)	1	1	1.00	EA	115.00	69.00	-	1.10	1.50	1.10	102.4	67.8	130	70	0	200
		MOTOR STARTER, NEMA 1, 460 V, NEMA 0 (THRU 5 HP)	1	1	1.00	EA	145.00	93.00	-	1.10	1.50	1.10	102.4	67.8	163	95	0	258
		MOTOR CONNECTION W/ FLEX CONDUIT, 5 HP	1	1	1.00	EA	3.55	26.50	-	1.10	1.51	1.10	102.4	67.8	4	27	0	31
		WIRE, TYPE THWN, COPPER, STRANDED, #14 (THRU 5 HP)	50	4	1.00	LF	0.05	0.16	-	1.10	1.48	1.10	102.4	67.8	11	33	0	44
		CONDUIT, RIGID GALV STL, 1/2" (THRU 4-#10)	50	1	1.00	LF	1.20	2.37	-	1.10	1.50	1.10	102.4	67.8	68	121	0	189
		DEMOLITION, PUMP/PIPING/STARTER/CONDUIT	1	0.40	1.00	LOT	-	2000	200	-	1.65	1.10	-	70.5	0	931	88	1019
		SUBTOTAL													3681	3273	227	7181
		CONTINGENCY					15 %	15 %	15 %						552	491	34	1077
135	2	TOTAL													4233	3764	261	8258
135	2	ADDTL COST (PIPING) TO COMBINE CHILLERS																
		PIPE, STL, SCH 40, WELD, 4"	20	2	1.00	LF	9.45	11.00	1.38	1.10	1.65	1.10	100.0	70.5	416	512	61	989
		ELBOW, STL, STD WGHT, WELD, 4"	2	2	1.00	EA	17.15	81.50	10.25	1.10	1.66	1.10	100.0	70.5	75	382	45	502
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 4"	20	2	1.00	LF	1.95	2.77	-	1.10	1.61	1.10	100.0	70.5	86	126	0	212
		SUBTOTAL													577	1020	106	1703
		CONTINGENCY					15 %	15 %	15 %						87	153	16	256
135	2	TOTAL													664	1173	122	1959
135	2	ADDTL COST (PIPING) TO COMBINE COOLING TOWERS																
		PIPE, STL, SCH 40, WELD, 4"	30	2	1.00	LF	9.45	11.00	1.38	1.10	1.65	1.10	100.0	70.5	624	768	91	1483
		ELBOW, STL, STD WGHT, WELD, 4"	6	2	1.00	EA	17.15	81.50	10.25	1.10	1.66	1.10	100.0	70.5	226	1145	135	1506
		DEMOLITION, PIPE, STL, SCH 40, WELD, 4"	60	0.40	1.00	LF	-	11.00	-	-	1.65	-	-	70.5	0	307	0	307
		SUBTOTAL													850	2220	226	3296
		CONTINGENCY					15 %	15 %	15 %						128	333	34	495
135	2	TOTAL													978	2553	260	3791
135	3	DEMOLISH CHILLER																
		DEMOLITION, CHILLER/PIPING/STARTER/CONDUIT	54.9	0.40	1.00	TONS	- (	77)	-	-	-	-	-	-	0	1691	0	1691
		SUBTOTAL													0	1691	0	1691
		CONTINGENCY					15 %	15 %	15 %						0	254	0	254
135	3	TOTAL													0	1945	0	1945
135	3	ADDTL COST (EQUIP) TO DEMOLISH COOLING TOWER																
		DEMOLITION, COOLING TOWER/PIPING/STARTER/CONDUIT	54.9	1.00	1.00	TONS	- (	7)	-	-	-	-	-	-	0	384	0	384
		SUBTOTAL													0	384	0	384
		CONTINGENCY					15 %	15 %	15 %						0	58	0	58
135	3	TOTAL													0	442	0	442
135	3	ADDTL COST (EQUIP) TO DEMOLISH COND WATER PUMP																
		DEMOLITION, PUMP/PIPING/STARTER/CONDUIT	1	0.40	1.00	LOT	-	2000	200	-	1.65	1.10	-	70.5	0	931	88	1019
		SUBTOTAL													0	931	88	1019
		CONTINGENCY					15 %	15 %	15 %						0	140	13	153
135	3	TOTAL													0	1071	101	1172

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Table I-4. ECO-1 Calculation of Construction Cost

PLANT BLDG NO	MASTER CHILLER NO	ITEM	QTY PER CHIL or 1-WAY RUN	QTY ADJUST FACTOR	LABOR DIFFIC ADJUST FACTOR	UNIT	UNIT BARE (TOT) MTL COST $/UNIT	UNIT BARE (TOT) LAB COST $/UNIT	UNIT BARE (TOT) EQP COST $/UNIT	MTL MARK UP %	LAB OH&P %	EQP MARK UP %	MTL COST ADJUST (AUSTIN) %	LAB COST ADJUST (AUSTIN) %	MTL COST $	LAB COST $	EQP COST $	TOTAL COST $
135	3	ADDTL COST (PIPING) TO DEMOLISH COOLING TOWER																
		DEMOLITION, PIPE, STL, SCH 40, WELD, 4"	60	0.40	1.00	LF	-	11.00	-	-	1.65	-	-	70.5	0	307	0	307
		SUBTOTAL													0	307	0	307
		CONTINGENCY					15 %	15 %	15 %						0	46	0	46
135	3	TOTAL													0	353	0	353
194	4	REPLACE (DOWNSIZE) CHILLER																
		CHILLER - RECIPROCATING, WATER-COOLED	107.0	1	1.25	TONS	249)(	77)(	5)	-	-	-	-	-	26643	10299	535	37477
		PIPE, STL, SCH 40, WELD, 4"	10	2	1.00	LF	9.45	11.00	1.38	1.10	1.65	1.10	100.0	70.5	208	256	30	494
		ELBOW, STL, STD WGHT, WELD, 4"	2	2	1.00	EA	17.15	81.50	10.25	1.10	1.66	1.10	100.0	70.5	75	382	45	502
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 4"	1	2	1.00	EA	360.00	51.00	-	1.10	1.55	1.10	100.0	70.5	792	111	0	903
		FLANGE, STL, 150 LB, WELD NECK, 4"	3	2	1.00	EA	24.00	41.00	5.10	1.10	1.65	1.10	100.0	70.5	158	286	34	478
		VALVE, IRON, BUTTERFLY, LUG, 4"	1	2	1.00	EA	92.00	81.50	-	1.10	1.52	1.10	100.0	70.5	202	175	0	377
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 4"	10	2	1.00	LF	1.95	2.77	-	1.10	1.61	1.10	100.0	70.5	43	63	0	106
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		START/DISCON, WYE-DELTA, OPEN, NEMA TYPE 1	123	1	1.00	HP	29.16	5.21	-	1.10	1.51	1.10	102.4	67.8	4040	656	0	4696
		MOTOR CONNECTION W/ FLEX CONDUIT, 125 HP	1	2	1.00	EA	30.00	107.00	-	1.10	1.50	1.10	102.4	67.8	68	218	0	286
		WIRE, TYPE THWN, COPPER, STRANDED, 2/0	70	4	1.00	LF	1.32	0.74	-	1.10	1.51	1.10	102.4	67.8	416	211	0	627
		CONDUIT, RIGID GALV STL, 2"	70	1	1.00	LF	4.00	4.75	-	1.10	1.51	1.10	102.4	67.8	315	340	0	655
		DEMOLITION, CHILLER/PIPING/STARTER/CONDUIT	228.0	0.40	1.25	TONS	- (	112)	-	-	-	-	-	-	0	12768	0	12768
		SUBTOTAL													35056	27606	754	63416
		CONTINGENCY					15 %	15 %	15 %						5258	4141	113	9512
194	4	TOTAL													40314	31747	867	72928
410	6 (7 SIM)	REPLACE (UPSIZE) CHILLER																
		CHILLER - CENTRIFUGAL, WATER-COOLED	119.0	1	1.00	TONS	426)(	128)(	0)	-	-	-	-	-	50694	15232	0	65926
		PIPE, STL, SCH 40, WELD, 4"	10	2	1.00	LF	9.45	11.00	1.38	1.10	1.65	1.10	100.0	70.5	208	256	30	494
		ELBOW, STL, STD WGHT, WELD, 4"	2	2	1.00	EA	17.15	81.50	10.25	1.10	1.66	1.10	100.0	70.5	75	382	45	502
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 4"	1	2	1.00	EA	360.00	51.00	-	1.10	1.55	1.10	100.0	70.5	792	111	0	903
		FLANGE, STL, 150 LB, WELD NECK, 4"	3	2	1.00	EA	24.00	41.00	5.10	1.10	1.65	1.10	100.0	70.5	158	286	34	478
		VALVE, IRON, BUTTERFLY, LUG, 4"	1	2	1.00	EA	92.00	81.50	-	1.10	1.52	1.10	100.0	70.5	202	175	0	377
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 4"	10	2	1.00	LF	1.95	2.77	-	1.10	1.61	1.10	100.0	70.5	43	63	0	106
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		START/DISCON, WYE-DELTA, OPEN, NEMA TYPE 1	110	1	1.00	HP	28.95	5.69	-	1.10	1.51	1.10	102.4	67.8	3587	641	0	4228
		MOTOR CONNECTION W/ FLEX CONDUIT, 125 HP	1	2	1.00	EA	30.00	107.00	-	1.10	1.50	1.10	102.4	67.8	68	218	0	286
		WIRE, TYPE THWN, COPPER, STRANDED, 1/0	70	4	1.00	LF	1.14	0.65	-	1.10	1.50	1.10	102.4	67.8	360	184	0	544
		CONDUIT, RIGID GALV STL, 1-1/2"	70	1	1.00	LF	3.15	3.88	-	1.10	1.50	1.10	102.4	67.8	248	276	0	524
		DEMOLITION, CHILLER/PIPING/STARTER/CONDUIT	110.0	0.40	1.00	TONS	- (	129)	-	-	-	-	-	-	0	5676	0	5676
		SUBTOTAL													58531	25341	219	84091
		CONTINGENCY					15 %	15 %	15 %						8780	3801	33	12614
410	6 (7)	TOTAL													67311	29142	252	96705

APPENDIX I

Table I-4. ECO-1 Calculation of Construction Cost

PLANT BLDG NO	MASTER CHILLER NO	ITEM	QTY PER CHIL or 1-WAY RUN	QTY ADJUST FACTOR	LABOR DIFFIC ADJUST FACTOR	UNIT	UNIT BARE (TOT) MTL COST $/UNIT	UNIT BARE (TOT) LAB COST $/UNIT	UNIT BARE (TOT) EQP COST $/UNIT	MTL MARK UP %	LAB OH&P %	EQP MARK UP %	MTL COST ADJUST (AUSTIN) %	LAB COST ADJUST (AUSTIN) %	MTL COST $	LAB COST $	EQP COST $	TOTAL COST $
2805	8	REPLACE (DOWNSIZE) CHILLER																
		CHILLER - RECIPROCATING, WATER-COOLED	116.0	1	1.00	TONS	254)(	77)(	5)	-	-	-	-	-	29464	8932	580	38976
		PIPE, STL, SCH 40, WELD, 4"	10	2	1.00	LF	9.45	11.00	1.38	1.10	1.65	1.10	100.0	70.5	208	256	30	494
		ELBOW, STL, STD WGHT, WELD, 4"	2	2	1.00	EA	17.15	81.50	10.25	1.10	1.66	1.10	100.0	70.5	75	382	45	502
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 4"	1	2	1.00	EA	360.00	51.00	-	1.10	1.55	1.10	100.0	70.5	792	111	0	903
		FLANGE, STL, 150 LB, WELD NECK, 4"	3	2	1.00	EA	24.00	41.00	5.10	1.10	1.65	1.10	100.0	70.5	158	286	34	478
		VALVE, IRON, BUTTERFLY, LUG, 4"	1	2	1.00	EA	92.00	81.50	-	1.10	1.52	1.10	100.0	70.5	202	175	0	377
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 4"	10	2	1.00	LF	1.95	2.77	-	1.10	1.61	1.10	100.0	70.5	43	63	0	106
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		START/DISCON, WYE-DELTA, OPEN, NEMA TYPE 1	134	1	1.00	HP	29.34	4.80	-	1.10	1.51	1.10	102.4	67.8	4429	658	0	5087
		MOTOR CONNECTION W/ FLEX CONDUIT, 150 HP	1	2	1.00	EA	47.00	119.00	-	1.10	1.50	1.10	102.4	67.8	106	242	0	348
		WIRE, TYPE THWN, COPPER, STRANDED, 2/0	70	4	1.00	LF	1.32	0.74	-	1.10	1.51	1.10	102.4	67.8	416	211	0	627
		CONDUIT, RIGID GALV STL, 2"	70	1	1.00	LF	4.00	4.75	-	1.10	1.51	1.10	102.4	67.8	315	340	0	655
		DEMOLITION, CHILLER/PIPING/STARTER/CONDUIT	149.8	0.40	1.00	TONS	- (	126)	-	-	-	-	-	-	0	7550	0	7550
		SUBTOTAL													38304	21047	799	60150
		CONTINGENCY					15 %	15 %	15 %						5746	3157	120	9023
2805	8	TOTAL													44050	24204	919	69173
2805	8	ADDTL COST (PIPING) TO RELOCATE CHILLER																
		PIPE, STL, SCH 40, WELD, 4"	10	2	1.00	LF	9.45	11.00	1.38	1.10	1.65	1.10	100.0	70.5	208	256	30	494
		ELBOW, STL, STD WGHT, WELD, 4"	2	2	1.00	EA	17.15	81.50	10.25	1.10	1.66	1.10	100.0	70.5	75	382	45	502
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 4"	10	2	1.00	LF	1.95	2.77	-	1.10	1.61	1.10	100.0	70.5	43	63	0	106
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		SUBTOTAL													913	1683	151	2747
		CONTINGENCY					15 %	15 %	15 %						137	252	23	412
2805	8	TOTAL													1050	1935	174	3159
5764	9	REPLACE (COMBINE/DOWNSIZE) CHILLER(S)																
		CHILLER - CENTRIFUGAL, WATER-COOLED	201.0	1	1.25	TONS	294)(	117)(	0)	-	-	-	-	-	59094	29396	0	88490
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 6"	10	2	1.00	LF	2.25	3.52	-	1.10	1.61	1.10	100.0	70.5	50	80	0	130
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		START/DISCON, WYE-DELTA, OPEN, NEMA TYPE 1	183	1	1.00	HP	28.94	3.83	-	1.10	1.51	1.10	102.4	67.8	5965	718	0	6683
		MOTOR CONNECTION W/ FLEX CONDUIT, 200 HP	1	2	1.00	EA	79.00	142.00	-	1.10	1.50	1.10	102.4	67.8	178	289	0	467
		WIRE, TYPE THWN, COPPER, STRANDED, 250 MCM	70	4	1.00	LF	2.35	1.07	-	1.10	1.51	1.10	102.4	67.8	741	307	0	1048
		CONDUIT, RIGID GALV STL, 2-1/2"	70	1	1.00	LF	6.70	6.10	-	1.10	1.50	1.10	102.4	67.8	528	434	0	962
		DEMOLITION, CHILLER/PIPING/STARTER/CONDUIT	178.0	0.40	1.25	TONS	- (	121)	-	-	-	-	-	-	0	10769	0	10769
		SUBTOTAL													70748	45675	220	116643
		CONTINGENCY					15 %	15 %	15 %						10612	6851	33	17496
5764	9	TOTAL													81360	52526	253	134139

APPENDIX I

Table I-4. ECO-1 Calculation of Construction Cost

PLANT BLDG NO	MASTER CHILLER NO	ITEM	QTY PER CHIL or 1-WAY RUN	QTY ADJUST FACTOR	LABOR DIFFIC ADJUST FACTOR	UNIT	UNIT BARE (TOT) MTL COST $/UNIT	UNIT BARE (TOT) LAB COST $/UNIT	UNIT BARE (TOT) EQP COST $/UNIT	MTL MARK UP %	LAB OH&P %	EQP MARK UP %	MTL COST ADJUST (AUSTIN) %	LAB COST ADJUST (AUSTIN) %	MTL COST $	LAB COST $	EQP COST $	TOTAL COST $
5764	9	ADDTL COST (EQUIP) TO REPLACE (UPSIZE) COOLING TOWER																
		COOLING TOWER - OPEN, AXIAL FAN	201.0	1	1.00	TONS	45)(	5)	-	-	-	-	-	-	9045	1005	0	10050
		CONCRETE FOUNDATION SUPPORT, 12"W x 36"H	9	2	1.00	LF	15.11	9.11	0.37	1.10	1.64	1.10	75.5	71.4	226	192	7	425
		CRANE, TRUCK MOUNTED, 12 TON	1	1	1.00	LIFT	-	-	-	-	-	-	-	-	-	125	400	525
		PIPE, STL, SCH 40, WELD, 6"	20	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	814	809	62	1685
		ELBOW, STL, STD WGHT, WELD, 6"	4	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	361	1153	90	1604
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		DISCONNECT SWITCH, NEMA 4, 460 V, 30 A (THRU 15 HP)	1	1	1.00	EA	115.00	69.00	-	1.10	1.50	1.10	102.4	67.8	130	70	0	200
		MOTOR STARTER, NEMA 1, 460 V, NEMA 1 (THRU 10 HP)	1	1	1.00	EA	165.00	134.00	-	1.10	1.52	1.10	102.4	67.8	186	138	0	324
		MOTOR CONNECTION W/ FLEX CONDUIT, 10 HP	1	1	1.00	EA	3.55	26.50	-	1.10	1.51	1.10	102.4	67.8	4	27	0	31
		WIRE, TYPE THWN, COPPER, STRANDED, #10 (THRU 10 HP)	50	4	1.00	LF	0.12	0.22	-	1.10	1.48	1.10	102.4	67.8	27	43	0	70
		CONDUIT, RIGID GALV STL, 1/2" (THRU 4-#10)	50	1	1.00	LF	1.20	2.37	-	1.10	1.50	1.10	102.4	67.8	68	121	0	189
		DEMOLITION, COOLING TOWER/PIPING/STARTER/CONDUIT	178.0	1.00	1.00	TONS	- (	5)	-	-	-	-	-	-	0	890	0	890
		SUBTOTAL													11435	5281	593	17309
		CONTINGENCY					15 %	15 %	15 %						1715	792	89	2596
5764	9	TOTAL													13150	6073	682	19905
5764	10	DEMOLISH CHILLER																
		DEMOLITION, CHILLER/PIPING/STARTER/CONDUIT	71.6	0.40	1.00	TONS	- (	90)	-	-	-	-	-	-	0	2578	0	2578
		SUBTOTAL													0	2578	0	2578
		CONTINGENCY					15 %	15 %	15 %						0	387	0	387
5764	10	TOTAL													0	2965	0	2965
5764	10	ADDTL COST (PIPING) TO DEMOLISH CHILLER																
		DEMOLITION, PIPE, STL, SCH 40, WELD, 4", w/ TRACING	220	0.60	1.00	LF	-	11.00	-	-	1.65	-	-	70.5	0	1689	0	1689
		SUBTOTAL													0	1689	0	1689
		CONTINGENCY					15 %	15 %	15 %						0	253	0	253
5764	10	TOTAL													0	1942	0	1942
5792	11	REPLACE CHILLER																
		CHILLER - CENTRIFUGAL, WATER-COOLED	170.0	1	1.25	TONS	331)(	123)(	0)	-	-	-	-	-	56270	26138	0	82408
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 6"	10	2	1.00	LF	2.25	3.52	-	1.10	1.61	1.10	100.0	70.5	50	80	0	130
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		START/DISCON, WYE-DELTA, OPEN, NEMA TYPE 1	152	1	1.00	HP	29.56	4.18	-	1.10	1.51	1.10	102.4	67.8	5061	650	0	5711
		MOTOR CONNECTION W/ FLEX CONDUIT, 200 HP	1	2	1.00	EA	79.00	142.00	-	1.10	1.50	1.10	102.4	67.8	178	289	0	467
		WIRE, TYPE THWN, COPPER, STRANDED, 3/0	70	4	1.00	LF	1.65	0.86	-	1.10	1.50	1.10	102.4	67.8	520	243	0	763
		CONDUIT, RIGID GALV STL, 2"	70	1	1.00	LF	4.00	4.75	-	1.10	1.51	1.10	102.4	67.8	315	340	0	655
		DEMOLITION, CHILLER/PIPING/STARTER/CONDUIT	170.0	0.40	1.25	TONS	- (	123)	-	-	-	-	-	-	0	10455	0	10455
		SUBTOTAL													66586	41877	220	108683
		CONTINGENCY					15 %	15 %	15 %						9988	6282	33	16303
5792	11	TOTAL													76574	48159	253	124986

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Table I-4. ECO-1 Calculation of Construction Cost

PLANT BLDG NO	MASTER CHILLER NO	ITEM	QTY PER CHIL or 1-WAY RUN	QTY ADJUST FACTOR	LABOR DIFFIC ADJUST FACTOR	UNIT	UNIT BARE (TOT) MTL COST	UNIT BARE (TOT) LAB COST	UNIT BARE (TOT) EQP COST	MTL MARK UP	LAB OH&P	EQP MARK UP	MTL COST ADJUST (AUSTIN)	LAB COST ADJUST (AUSTIN)	MTL COST	LAB COST	EQP COST	TOTAL COST
							$/UNIT	$/UNIT	$/UNIT	%	%	%	%	%	$	$	$	$
7050	12 (13 SIM)	REPLACE (DOWNSIZE) CHILLER																
		CHILLER - CENTRIFUGAL, WATER-COOLED	153.0	1	1.10	TONS	351)(	125)(	0)	-	-	-	-	-	53703	21038	0	74741
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 6"	10	2	1.00	LF	2.25	3.52	-	1.10	1.61	1.10	100.0	70.5	50	80	0	130
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		START/DISCON, WYE-DELTA, OPEN, NEMA TYPE 1	135	1	1.00	HP	29.36	4.76	-	1.10	1.51	1.10	102.4	67.8	4465	658	0	5123
		MOTOR CONNECTION W/ FLEX CONDUIT, 150 HP	1	2	1.00	EA	47.00	119.00	-	1.10	1.50	1.10	102.4	67.8	106	242	0	348
		WIRE, TYPE THWN, COPPER, STRANDED, 2/0	70	4	1.00	LF	1.32	0.74	-	1.10	1.51	1.10	102.4	67.8	416	211	0	627
		CONDUIT, RIGID GALV STL, 2"	70	1	1.00	LF	4.00	4.75	-	1.10	1.51	1.10	102.4	67.8	315	340	0	655
		DEMOLITION, CHILLER/PIPING/STARTER/CONDUIT	210.0	0.40	1.10	TONS	- (	116)	-	-	-	-	-	-	0	10718	0	10718
		SUBTOTAL													63247	36969	220	100436
		CONTINGENCY					15 %	15 %	15 %						9487	5545	33	15065
7050	12 (13)	TOTAL													72734	42514	253	115501
7051	14	REPLACE (DOWNSIZE) CHILLER																
		CHILLER - CENTRIFUGAL, WATER-COOLED	158.0	1	1.10	TONS	345)(	125)(	0)	-	-	-	-	-	54510	21725	0	76235
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 6"	10	2	1.00	LF	2.25	3.52	-	1.10	1.61	1.10	100.0	70.5	50	80	0	130
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		START/DISCON, WYE-DELTA, OPEN, NEMA TYPE 1	140	1	1.00	HP	29.44	4.57	-	1.10	1.51	1.10	102.4	67.8	4643	655	0	5298
		MOTOR CONNECTION W/ FLEX CONDUIT, 150 HP	1	2	1.00	EA	47.00	119.00	-	1.10	1.50	1.10	102.4	67.8	106	242	0	348
		WIRE, TYPE THWN, COPPER, STRANDED, 3/0	70	4	1.00	LF	1.65	0.86	-	1.10	1.50	1.10	102.4	67.8	520	243	0	763
		CONDUIT, RIGID GALV STL, 2"	70	1	1.00	LF	4.00	4.75	-	1.10	1.51	1.10	102.4	67.8	315	340	0	655
		DEMOLITION, CHILLER/PIPING/STARTER/CONDUIT	170.0	0.40	1.10	TONS	- (	123)	-	-	-	-	-	-	0	9200	0	9200
		SUBTOTAL													64336	36167	220	100723
		CONTINGENCY					15 %	15 %	15 %						9650	5425	33	15108
7051	14	TOTAL													73986	41592	253	115831

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Table I-4. ECO-1 Calculation of Construction Cost

PLANT BLDG NO	MASTER CHILLER NO	ITEM	QTY PER CHIL or 1-WAY RUN	QTY ADJUST FACTOR	LABOR DIFFIC ADJUST FACTOR	UNIT	UNIT BARE (TOT) MTL COST $/UNIT	UNIT BARE (TOT) LAB COST $/UNIT	UNIT BARE (TOT) EQP COST $/UNIT	MTL MARK UP %	LAB OH&P %	EQP MARK UP %	MTL COST ADJUST (AUSTIN) %	LAB COST ADJUST (AUSTIN) %	MTL COST $	LAB COST $	EQP COST $	TOTAL COST $
14020	20	REPLACE (UPSIZE) CHILLER																
		CHILLER - CENTRIFUGAL, WATER-COOLED	154.0	1	1.25	TONS	350)(	125)(	0)	-	-	-	-	-	53900	24063	0	77963
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 6"	10	2	1.00	LF	2.25	3.52	-	1.10	1.61	1.10	100.0	70.5	50	80	0	130
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		START/DISCON, WYE-DELTA, OPEN, NEMA TYPE 1	135	1	1.00	HP	29.36	4.76	-	1.10	1.51	1.10	102.4	67.8	4465	658	0	5123
		MOTOR CONNECTION W/ FLEX CONDUIT, 150 HP	1	2	1.00	EA	47.00	119.00	-	1.10	1.50	1.10	102.4	67.8	106	242	0	348
		WIRE, TYPE THWN, COPPER, STRANDED, 3/0	70	4	1.00	LF	1.65	0.86	-	1.10	1.50	1.10	102.4	67.8	520	243	0	763
		CONDUIT, RIGID GALV STL, 2"	70	1	1.00	LF	4.00	4.75	-	1.10	1.51	1.10	102.4	67.8	315	340	0	655
		DEMOLITION, CHILLER/PIPING/STARTER/CONDUIT	140.4	0.40	1.25	TONS	- (	127)	-	-	-	-	-	-	0	8915	0	8915
		SUBTOTAL													63548	38223	220	101991
		CONTINGENCY					15 %	15 %	15 %						9532	5733	33	15298
14020	20	TOTAL													73080	43956	253	117289
14020	20	ADDTL COST (EQUIP) TO REPLACE (UPSIZE) COOLING TOWER																
		COOLING TOWER - OPEN, AXIAL FAN	154.0	1	1.00	TONS	48)(	6)	-	-	-	-	-	-	7392	924	0	8316
		CONCRETE FOUNDATION SUPPORT, 12"W x 36"H	12	2	1.00	LF	15.11	9.11	0.37	1.10	1.64	1.10	75.5	71.4	301	256	10	567
		CRANE, TRUCK MOUNTED, 12 TON	1	1	1.00	LIFT	-	-	-	-	-	-	-	-	-	125	400	525
		PIPE, STL, SCH 40, WELD, 6"	20	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	814	809	62	1685
		ELBOW, STL, STD WGHT, WELD, 6"	4	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	361	1153	90	1604
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		DISCONNECT SWITCH, NEMA 4, 460 V, 30 A (THRU 15 HP)	2	1	1.00	EA	115.00	69.00	-	1.10	1.50	1.10	102.4	67.8	259	140	0	399
		MOTOR STARTER, NEMA 1, 460 V, NEMA 0 (THRU 5 HP)	2	1	1.00	EA	145.00	93.00	-	1.10	1.50	1.10	102.4	67.8	327	189	0	516
		MOTOR CONNECTION W/ FLEX CONDUIT, 5 HP	2	1	1.00	EA	3.55	26.50	-	1.10	1.51	1.10	102.4	67.8	8	54	0	62
		WIRE, TYPE THWN, COPPER, STRANDED, #14 (THRU 5 HP)	100	4	1.00	LF	0.05	0.16	-	1.10	1.48	1.10	102.4	67.8	23	66	0	89
		CONDUIT, RIGID GALV STL, 1/2" (THRU 4-#10)	100	1	1.00	LF	1.20	2.37	-	1.10	1.50	1.10	102.4	67.8	135	241	0	376
		DEMOLITION, COOLING TOWER/PIPING/STARTER/CONDUIT	140.4	1.00	1.00	TONS	- (	6)	-	-	-	-	-	-	0	842	0	842
		SUBTOTAL													10194	5507	596	16297
		CONTINGENCY					15 %	15 %	15 %						1529	826	89	2444
14020	20	TOTAL													11723	6333	685	18741

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Table I-4. ECO-1 Calculation of Construction Cost

PLANT BLDG NO	MASTER CHILLER NO	ITEM	QTY PER CHIL or 1-WAY RUN	QTY ADJUST FACTOR	LABOR DIFFIC ADJUST FACTOR	UNIT	UNIT BARE (TOT) MTL COST $/UNIT	UNIT BARE (TOT) LAB COST $/UNIT	UNIT BARE (TOT) EQP COST $/UNIT	MTL MARK UP %	LAB OH&P %	EQP MARK UP %	MTL COST ADJUST (AUSTIN) %	LAB COST ADJUST (AUSTIN) %	MTL COST $	LAB COST $	EQP COST $	TOTAL COST $
14023	21	REPLACE (UPSIZE) CHILLER																
		CHILLER - CENTRIFUGAL, WATER-COOLED	166.0	1	1.25	TONS	336)(	123)(	0)	-	-	-	-	-	55776	25523	0	81299
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 6"	10	2	1.00	LF	2.25	3.52	-	1.10	1.61	1.10	100.0	70.5	50	80	0	130
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		START/DISCON, WYE-DELTA, OPEN, NEMA TYPE 1	148	1	1.00	HP	29.57	4.27	-	1.10	1.51	1.10	102.4	67.8	4930	647	0	5577
		MOTOR CONNECTION W/ FLEX CONDUIT, 150 HP	1	2	1.00	EA	47.00	119.00	-	1.10	1.50	1.10	102.4	67.8	106	242	0	348
		WIRE, TYPE THWN, COPPER, STRANDED, 3/0	70	4	1.00	LF	1.65	0.86	-	1.10	1.50	1.10	102.4	67.8	520	243	0	763
		CONDUIT, RIGID GALV STL, 2"	70	1	1.00	LF	4.00	4.75	-	1.10	1.51	1.10	102.4	67.8	315	340	0	655
		DEMOLITION, CHILLER/PIPING/STARTER/CONDUIT	146.0	0.40	1.25	TONS	- (	126)	-	-	-	-	-	-	0	9198	0	9198
		SUBTOTAL													65889	39955	220	106064
		CONTINGENCY					15 %	15 %	15 %						9883	5993	33	15909
14023	21	TOTAL													75772	45948	253	121973
14023	21	ADDTL COST (EQUIP) TO REPLACE (UPSIZE) COOLING TOWER																
		COOLING TOWER - OPEN, AXIAL FAN	166.0	1	1.00	TONS	46)(	6)	-	-	-	-	-	-	7636	996	0	8632
		CONCRETE FOUNDATION SUPPORT, 12"W x 36"H	12	2	1.00	LF	15.11	9.11	0.37	1.10	1.64	1.10	75.5	71.4	301	256	10	567
		CRANE, TRUCK MOUNTED, 12 TON	1	1	1.00	LIFT	-	-	-	-	-	-	-	-	-	125	400	525
		PIPE, STL, SCH 40, WELD, 6"	20	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	814	809	62	1685
		ELBOW, STL, STD WGHT, WELD, 6"	4	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	361	1153	90	1604
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		DISCONNECT SWITCH, NEMA 4, 460 V, 30 A (THRU 15 HP)	2	1	1.00	EA	115.00	69.00	-	1.10	1.50	1.10	102.4	67.8	259	140	0	399
		MOTOR STARTER, NEMA 1, 460 V, NEMA 0 (THRU 5 HP)	2	1	1.00	EA	145.00	93.00	-	1.10	1.50	1.10	102.4	67.8	327	189	0	516
		MOTOR CONNECTION W/ FLEX CONDUIT, 5 HP	2	1	1.00	EA	3.55	26.50	-	1.10	1.51	1.10	102.4	67.8	8	54	0	62
		WIRE, TYPE THWN, COPPER, STRANDED, #14 (THRU 5 HP)	100	4	1.00	LF	0.05	0.16	-	1.10	1.48	1.10	102.4	67.8	23	66	0	89
		CONDUIT, RIGID GALV STL, 1/2" (THRU 4-#10)	100	1	1.00	LF	1.20	2.37	-	1.10	1.50	1.10	102.4	67.8	135	241	0	376
		DEMOLITION, COOLING TOWER/PIPING/STARTER/CONDUIT	146.0	1.00	1.00	TONS	- (	6)	-	-	-	-	-	-	0	876	0	876
		SUBTOTAL													10438	5613	596	16647
		CONTINGENCY					15 %	15 %	15 %						1566	842	89	2497
14023	21	TOTAL													12004	6455	685	19144

APPENDIX I

Table I-4. ECO-1 Calculation of Construction Cost

PLANT BLDG NO	MASTER CHILLER NO	ITEM	QTY PER CHIL or 1-WAY RUN	QTY ADJUST FACTOR	LABOR DIFFIC ADJUST FACTOR	UNIT	UNIT BARE (TOT) MTL COST $/UNIT	UNIT BARE (TOT) LAB COST $/UNIT	UNIT BARE (TOT) EQP COST $/UNIT	MTL MARK UP %	LAB OH&P %	EQP MARK UP %	MTL COST ADJUST (AUSTIN) %	LAB COST ADJUST (AUSTIN) %	MTL COST $	LAB COST $	EQP COST $	TOTAL COST $
21002	22	REPLACE (UPSIZE) CHILLER																
		CHILLER - CENTRIFUGAL, WATER-COOLED	240.0	1	1.00	TONS	254)(	109)(	0)	-	-	-	-	-	60960	26160	0	87120
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 6"	10	2	1.00	LF	2.25	3.52	-	1.10	1.61	1.10	100.0	70.5	50	80	0	130
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		START/DISCON, WYE-DELTA, OPEN, NEMA TYPE 1	227	1	1.00	HP	28.07	3.34	-	1.10	1.51	1.10	102.4	67.8	7177	776	0	7953
		MOTOR CONNECTION W/ FLEX CONDUIT, 250 HP	1	2	1.00	EA	103.00	193.00	-	1.10	1.50	1.10	102.4	67.8	232	393	0	625
		WIRE, TYPE THWN, COPPER, STRANDED, 350 MCM	70	4	1.00	LF	3.15	1.19	-	1.10	1.50	1.10	102.4	67.8	993	339	0	1332
		CONDUIT, RIGID GALV STL, 3"	70	1	1.00	LF	8.60	8.55	-	1.10	1.53	1.10	102.4	67.8	678	621	0	1299
		DEMOLITION, CHILLER/PIPING/STARTER/CONDUIT	215.0	0.40	1.00	TONS	- (	115)	-	-	-	-	-	-	0	9890	0	9890
		SUBTOTAL													74282	41941	220	116443
		CONTINGENCY					15 %	15 %	15 %						11142	6291	33	17466
21002	22	TOTAL													85424	48232	253	133909
21002	22	ADDTL COST (EQUIP) TO REPLACE (UPSIZE) COOLING TOWER																
		COOLING TOWER - OPEN, AXIAL FAN	240.0	1	1.00	TONS	45)(	5)	-	-	-	-	-	-	10800	1200	0	12000
		CONCRETE FOUNDATION SUPPORT, 12"W x 36"H	9	2	1.00	LF	15.11	9.11	0.37	1.10	1.64	1.10	75.5	71.4	226	192	7	425
		CRANE, TRUCK MOUNTED, 12 TON	1	1	1.00	LIFT	-	-	-	-	-	-	-	-	-	125	400	525
		PIPE, STL, SCH 40, WELD, 6"	20	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	814	809	62	1685
		ELBOW, STL, STD WGHT, WELD, 6"	4	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	361	1153	90	1604
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		DISCONNECT SWITCH, NEMA 4, 460 V, 60 A (THRU 30 HP)	1	1	1.00	EA	195.00	97.00	-	1.10	1.50	1.10	102.4	67.8	220	99	0	319
		MOTOR STARTER, NEMA 1, 460 V, NEMA 2 (THRU 25 HP)	1	1	1.00	EA	325.00	194.00	-	1.10	1.51	1.10	102.4	67.8	366	199	0	565
		MOTOR CONNECTION W/ FLEX CONDUIT, 25 HP	1	1	1.00	EA	5.70	35.50	-	1.10	1.51	1.10	102.4	67.8	6	36	0	42
		WIRE, TYPE THWN, COPPER, STRANDED, #6 (THRU 30 HP)	50	4	1.00	LF	0.26	0.33	-	1.10	1.50	1.10	102.4	67.8	59	67	0	126
		CONDUIT, RIGID GALV STL, 3/4" (THRU 4-#6)	50	1	1.00	LF	1.50	2.67	-	1.10	1.50	1.10	102.4	67.8	84	136	0	220
		DEMOLITION, COOLING TOWER/PIPING/STARTER/CONDUIT	215.0	1.00	1.00	TONS	[illegible] - (	5)	-	-	-	-	-	-	0	1075	0	1075
		SUBTOTAL													13510	5799	593	19902
		CONTINGENCY					15 %	15 %	15 %						2027	870	89	2986
21002	22	TOTAL													15537	6669	682	22888
21002	22	ADDTL COST (PIPING) TO RELOCATE CHILLER																
		PIPE, STL, SCH 40, WELD, 6"	30	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	1221	1214	94	2529
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 6"	30	2	1.00	LF	2.25	3.52	-	1.10	1.61	1.10	100.0	70.5	149	240	0	389
		PIPE, STL, SCH 40, WELD, 6"	30	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	1221	1214	94	2529
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		SUBTOTAL													2951	3822	278	7051
		CONTINGENCY					15 %	15 %	15 %						443	573	42	1058
21002	22	TOTAL													3394	4395	320	8109

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Table I-4. ECO-1 Calculation of Construction Cost

PLANT BLDG NO	MASTER CHILLER NO	ITEM	QTY PER CHIL or 1-WAY RUN	QTY ADJUST FACTOR	LABOR DIFFIC ADJUST FACTOR	UNIT	UNIT BARE (TOT) MTL COST $/UNIT	UNIT BARE (TOT) LAB COST $/UNIT	UNIT BARE (TOT) EQP COST $/UNIT	MTL MARK UP %	LAB OH&P %	EQP MARK UP %	MTL COST ADJUST (AUSTIN) %	LAB COST ADJUST (AUSTIN) %	MTL COST $	LAB COST $	EQP COST $	TOTAL COST $
27004	23	REPLACE CHILLER																
		CHILLER - CENTRIFUGAL, WATER-COOLED	465.0	1	1.00	TONS	212)(	78)(	0)	-	-	-	-	-	98580	36270	0	134850
		PIPE, STL, SCH 40, WELD, 8"	10	2	1.00	LF	28.00	22.00	1.76	1.10	1.62	1.10	100.0	70.5	616	503	39	1158
		ELBOW, STL, STD WGHT, WELD, 8"	2	2	1.00	EA	77.00	159.00	12.80	1.10	1.61	1.10	100.0	70.5	339	722	56	1117
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 8"	1	2	1.00	EA	495.00	81.50	-	1.10	1.54	1.10	100.0	70.5	1089	177	0	1266
		FLANGE, STL, 150 LB, WELD NECK, 8"	3	2	1.00	EA	64.00	90.50	7.30	1.10	1.62	1.10	100.0	70.5	422	620	48	1090
		VALVE, IRON, BUTTERFLY, LUG, 8"	1	2	1.00	EA	215.00	141.00	-	1.10	1.51	1.10	100.0	70.5	473	300	0	773
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 8"	10	2	1.00	LF	2.82	4.30	-	1.10	1.60	1.10	100.0	70.5	62	97	0	159
		PIPE, STL, SCH 40, WELD, 8"	10	2	1.00	LF	28.00	22.00	1.76	1.10	1.62	1.10	100.0	70.5	616	503	39	1158
		ELBOW, STL, STD WGHT, WELD, 8"	2	2	1.00	EA	77.00	159.00	12.80	1.10	1.61	1.10	100.0	70.5	339	722	56	1117
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 8"	1	2	1.00	EA	495.00	81.50	-	1.10	1.54	1.10	100.0	70.5	1089	177	0	1266
		FLANGE, STL, 150 LB, WELD NECK, 8"	3	2	1.00	EA	64.00	90.50	7.30	1.10	1.62	1.10	100.0	70.5	422	620	48	1090
		VALVE, IRON, BUTTERFLY, LUG, 8"	1	2	1.00	EA	215.00	141.00	-	1.10	1.51	1.10	100.0	70.5	473	300	0	773
		START/DISCON, WYE-DELTA, OPEN, NEMA TYPE 1	367	1	1.00	HP	26.24	2.35	-	1.10	1.51	1.10	102.4	67.8	10847	883	0	11730
		MOTOR CONNECTION W/ FLEX CONDUIT, 200 HP	2	2	1.00	EA	79.00	142.00	-	1.10	1.50	1.10	102.4	67.8	356	578	0	934
		WIRE, TYPE THWN, COPPER, STRANDED, 250 MCM	70	8	1.00	LF	2.35	1.07	-	1.10	1.51	1.10	102.4	67.8	1482	613	0	2095
		CONDUIT, RIGID GALV STL, 2-1/2"	70	2	1.00	LF	6.70	6.10	-	1.10	1.50	1.10	102.4	67.8	1057	869	0	1926
		DEMOLITION, CHILLER/PIPING/STARTER/CONDUIT	465.0	0.40	1.00	TONS	- (	78)	-	-	-	-	-	-	0	14508	0	14508
		SUBTOTAL													118262	58462	286	177010
		CONTINGENCY					15 %	15 %	15 %						17739	8769	43	26551
27004	23	TOTAL													136001	67231	329	203561
28000	24 (25 SIM)	REPLACE (UPSIZE) CHILLER																
		CHILLER - CENTRIFUGAL, WATER-COOLED	119.0	1	1.00	TONS	426)(	128)(	0)	-	-	-	-	-	50694	15232	0	65926
		PIPE, STL, SCH 40, WELD, 4"	10	2	1.00	LF	9.45	11.00	1.38	1.10	1.65	1.10	100.0	70.5	208	256	30	494
		ELBOW, STL, STD WGHT, WELD, 4"	2	2	1.00	EA	17.15	81.50	10.25	1.10	1.66	1.10	100.0	70.5	75	382	45	502
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 4"	1	2	1.00	EA	360.00	51.00	-	1.10	1.55	1.10	100.0	70.5	792	111	0	903
		FLANGE, STL, 150 LB, WELD NECK, 4"	3	2	1.00	EA	24.00	41.00	5.10	1.10	1.65	1.10	100.0	70.5	158	286	34	478
		VALVE, IRON, BUTTERFLY, LUG, 4"	1	2	1.00	EA	92.00	81.50	-	1.10	1.52	1.10	100.0	70.5	202	175	0	377
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 4"	10	2	1.00	LF	1.95	2.77	-	1.10	1.61	1.10	100.0	70.5	43	63	0	106
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		START/DISCON, WYE-DELTA, OPEN, NEMA TYPE 1	110	1	1.00	HP	28.95	5.69	-	1.10	1.51	1.10	102.4	67.8	3587	641	0	4228
		MOTOR CONNECTION W/ FLEX CONDUIT, 125 HP	1	2	1.00	EA	30.00	107.00	-	1.10	1.50	1.10	102.4	67.8	68	218	0	286
		WIRE, TYPE THWN, COPPER, STRANDED, 1/0	70	4	1.00	LF	1.14	0.65	-	1.10	1.50	1.10	102.4	67.8	360	184	0	544
		CONDUIT, RIGID GALV STL, 1-1/2"	70	1	1.00	LF	3.15	3.88	-	1.10	1.50	1.10	102.4	67.8	248	276	0	524
		DEMOLITION, CHILLER/PIPING/STARTER/CONDUIT	110.0	0.40	1.00	TONS	- (	129)	-	-	-	-	-	-	0	5676	0	5676
		SUBTOTAL													58531	25341	219	84091
		CONTINGENCY					15 %	15 %	15 %						8780	3801	33	12614
28000	24 (25)	TOTAL													67311	29142	252	96705

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Table I-4. ECO-1 Calculation of Construction Cost

PLANT BLDG NO	MASTER CHILLER NO	ITEM	QTY PER CHIL or 1-WAY RUN	QTY ADJUST FACTOR	LABOR DIFFIC ADJUST FACTOR	UNIT	UNIT BARE (TOT) MTL COST $/UNIT	UNIT BARE (TOT) LAB COST $/UNIT	UNIT BARE (TOT) EQP COST $/UNIT	MTL MARK UP %	LAB OH&P %	EQP MARK UP %	MTL COST ADJUST (AUSTIN) %	LAB COST ADJUST (AUSTIN) %	MTL COST $	LAB COST $	EQP COST $	TOTAL COST $
29005	26 (27 SIM)	REPLACE (DOWNSIZE) CHILLER																
		CHILLER - CENTRIFUGAL, WATER-COOLED	426.6	1	1.00	TONS	223)(	82)(	0)	-	-	-	-	-	95132	34981	0	130113
		PIPE, STL, SCH 40, WELD, 8"	10	2	1.00	LF	28.00	22.00	1.76	1.10	1.62	1.10	100.0	70.5	616	503	39	1158
		ELBOW, STL, STD WGHT, WELD, 8"	2	2	1.00	EA	77.00	159.00	12.80	1.10	1.61	1.10	100.0	70.5	339	722	56	1117
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 8"	1	2	1.00	EA	495.00	81.50	-	1.10	1.54	1.10	100.0	70.5	1089	177	0	1266
		FLANGE, STL, 150 LB, WELD NECK, 8"	3	2	1.00	EA	64.00	90.50	7.30	1.10	1.62	1.10	100.0	70.5	422	620	48	1090
		VALVE, IRON, BUTTERFLY, LUG, 8"	1	2	1.00	EA	215.00	141.00	-	1.10	1.51	1.10	100.0	70.5	473	300	0	773
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 8"	10	2	1.00	LF	2.82	4.30	-	1.10	1.60	1.10	100.0	70.5	62	97	0	159
		PIPE, STL, SCH 40, WELD, 8"	10	2	1.00	LF	28.00	22.00	1.76	1.10	1.62	1.10	100.0	70.5	616	503	39	1158
		ELBOW, STL, STD WGHT, WELD, 8"	2	2	1.00	EA	77.00	159.00	12.80	1.10	1.61	1.10	100.0	70.5	339	722	56	1117
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 8"	1	2	1.00	EA	495.00	81.50	-	1.10	1.54	1.10	100.0	70.5	1089	177	0	1266
		FLANGE, STL, 150 LB, WELD NECK, 8"	3	2	1.00	EA	64.00	90.50	7.30	1.10	1.62	1.10	100.0	70.5	422	620	48	1090
		VALVE, IRON, BUTTERFLY, LUG, 8"	1	2	1.00	EA	215.00	141.00	-	1.10	1.51	1.10	100.0	70.5	473	300	0	773
		START/DISCON, WYE-DELTA, OPEN, NEMA TYPE 1	332	1	1.00	HP	26.43	2.44	-	1.10	1.51	1.10	102.4	67.8	9884	829	0	10713
		MOTOR CONNECTION W/ FLEX CONDUIT, 200 HP	2	2	1.00	EA	79.00	142.00	-	1.10	1.50	1.10	102.4	67.8	356	578	0	934
		WIRE, TYPE THWN, COPPER, STRANDED, 4/0	70	8	1.00	LF	2.00	0.97	-	1.10	1.49	1.10	102.4	67.8	1262	549	0	1811
		CONDUIT, RIGID GALV STL, 2"	70	2	1.00	LF	4.00	4.75	-	1.10	1.51	1.10	102.4	67.8	631	681	0	1312
		DEMOLITION, CHILLER/PIPING/STARTER/CONDUIT	474.0	0.40	1.00	TONS	- (	77)	-	-	-	-	-	-	0	14599	0	14599
		SUBTOTAL													113205	56958	286	170449
		CONTINGENCY					15 %	15 %	15 %						16981	8544	43	25568
29005	26 (27)	TOTAL													130186	65502	329	196017
36000	30 (31 SIM)	REPLACE CHILLER																
		CHILLER - CENTRIFUGAL, WATER-COOLED	425.7	1	1.00	TONS	223)(	82)(	0)	-	-	-	-	-	94931	34907	0	129838
		PIPE, STL, SCH 40, WELD, 8"	10	2	1.00	LF	28.00	22.00	1.76	1.10	1.62	1.10	100.0	70.5	616	503	39	1158
		ELBOW, STL, STD WGHT, WELD, 8"	2	2	1.00	EA	77.00	159.00	12.80	1.10	1.61	1.10	100.0	70.5	339	722	56	1117
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 8"	1	2	1.00	EA	495.00	81.50	-	1.10	1.54	1.10	100.0	70.5	1089	177	0	1266
		FLANGE, STL, 150 LB, WELD NECK, 8"	3	2	1.00	EA	64.00	90.50	7.30	1.10	1.62	1.10	100.0	70.5	422	620	48	1090
		VALVE, IRON, BUTTERFLY, LUG, 8"	1	2	1.00	EA	215.00	141.00	-	1.10	1.51	1.10	100.0	70.5	473	300	0	773
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 8"	10	2	1.00	LF	2.82	4.30	-	1.10	1.60	1.10	100.0	70.5	62	97	0	159
		PIPE, STL, SCH 40, WELD, 8"	10	2	1.00	LF	28.00	22.00	1.76	1.10	1.62	1.10	100.0	70.5	616	503	39	1158
		ELBOW, STL, STD WGHT, WELD, 8"	2	2	1.00	EA	77.00	159.00	12.80	1.10	1.61	1.10	100.0	70.5	339	722	56	1117
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 8"	1	2	1.00	EA	495.00	81.50	-	1.10	1.54	1.10	100.0	70.5	1089	177	0	1266
		FLANGE, STL, 150 LB, WELD NECK, 8"	3	2	1.00	EA	64.00	90.50	7.30	1.10	1.62	1.10	100.0	70.5	422	620	48	1090
		VALVE, IRON, BUTTERFLY, LUG, 8"	1	2	1.00	EA	215.00	141.00	-	1.10	1.51	1.10	100.0	70.5	473	300	0	773
		START/DISCON, WYE-DELTA, OPEN, NEMA TYPE 1	331	1	1.00	HP	26.44	2.44	-	1.10	1.51	1.10	102.4	67.8	9858	827	0	10685
		MOTOR CONNECTION W/ FLEX CONDUIT, 200 HP	2	2	1.00	EA	79.00	142.00	-	1.10	1.50	1.10	102.4	67.8	356	578	0	934
		WIRE, TYPE THWN, COPPER, STRANDED, 4/0	70	8	1.00	LF	2.00	0.97	-	1.10	1.49	1.10	102.4	67.8	1262	549	0	1811
		CONDUIT, RIGID GALV STL, 2"	70	2	1.00	LF	4.00	4.75	-	1.10	1.51	1.10	102.4	67.8	631	681	0	1312
		DEMOLITION, CHILLER/PIPING/STARTER/CONDUIT	400.0	0.40	1.00	TONS	- (	84)	-	-	-	-	-	-	0	13440	0	13440
		SUBTOTAL													112978	55723	286	168987
		CONTINGENCY					15 %	15 %	15 %						16947	8358	43	25348
36000	30 (31)	TOTAL													129925	64081	329	194335

APPENDIX I

Table I-4. ECO-1 Calculation of Construction Cost

PLANT BLDG NO	MASTER CHILLER NO	ITEM	QTY PER CHIL or 1-WAY RUN	QTY ADJUST FACTOR	LABOR DIFFIC ADJUST FACTOR	UNIT	UNIT BARE (TOT) MTL COST $/UNIT	UNIT BARE (TOT) LAB COST $/UNIT	UNIT BARE (TOT) EQP COST $/UNIT	MTL MARK UP %	LAB OH&P %	EQP MARK UP %	MTL COST ADJUST (AUSTIN) %	LAB COST ADJUST (AUSTIN) %	MTL COST $	LAB COST $	EQP COST $	TOTAL COST $
36000	32	REPLACE CHILLER																
		CHILLER - CENTRIFUGAL, WATER-COOLED	425.7	1	1.00	TONS	223)(	82)(	0)	-	-	-	-	-	94931	34907	0	129838
		PIPE, STL, SCH 40, WELD, 8"	10	2	1.00	LF	28.00	22.00	1.76	1.10	1.62	1.10	100.0	70.5	616	503	39	1158
		ELBOW, STL, STD WGHT, WELD, 8"	2	2	1.00	EA	77.00	159.00	12.80	1.10	1.61	1.10	100.0	70.5	339	722	56	1117
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 8"	1	2	1.00	EA	495.00	81.50	-	1.10	1.54	1.10	100.0	70.5	1089	177	0	1266
		FLANGE, STL, 150 LB, WELD NECK, 8"	3	2	1.00	EA	64.00	90.50	7.30	1.10	1.62	1.10	100.0	70.5	422	620	48	1090
		VALVE, IRON, BUTTERFLY, LUG, 8"	1	2	1.00	EA	215.00	141.00	-	1.10	1.51	1.10	100.0	70.5	473	300	0	773
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 8"	10	2	1.00	LF	2.82	4.30	-	1.10	1.60	1.10	100.0	70.5	62	97	0	159
		PIPE, STL, SCH 40, WELD, 8"	10	2	1.00	LF	28.00	22.00	1.76	1.10	1.62	1.10	100.0	70.5	616	503	39	1158
		ELBOW, STL, STD WGHT, WELD, 8"	2	2	1.00	EA	77.00	159.00	12.80	1.10	1.61	1.10	100.0	70.5	339	722	56	1117
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 8"	1	2	1.00	EA	495.00	81.50	-	1.10	1.54	1.10	100.0	70.5	1089	177	0	1266
		FLANGE, STL, 150 LB, WELD NECK, 8"	3	2	1.00	EA	64.00	90.50	7.30	1.10	1.62	1.10	100.0	70.5	422	620	48	1090
		VALVE, IRON, BUTTERFLY, LUG, 8"	1	2	1.00	EA	215.00	141.00	-	1.10	1.51	1.10	100.0	70.5	473	300	0	773
		START/DISCON, WYE-DELTA, OPEN, NEMA TYPE 1	331	1	1.00	HP	26.44	2.44	-	1.10	1.51	1.10	102.4	67.8	9858	827	0	10685
		MOTOR CONNECTION W/ FLEX CONDUIT, 200 HP	2	2	1.00	EA	79.00	142.00	-	1.10	1.50	1.10	102.4	67.8	356	578	0	934
		WIRE, TYPE THWN, COPPER, STRANDED, 4/0	70	8	1.00	LF	2.00	0.97	-	1.10	1.49	1.10	102.4	67.8	1262	549	0	1811
		CONDUIT, RIGID GALV STL, 2"	70	2	1.00	LF	4.00	4.75	-	1.10	1.51	1.10	102.4	67.8	631	681	0	1312
		DEMOLITION, CHILLER/PIPING/STARTER/CONDUIT	477.0	0.40	1.00	TONS	- (	77)	-	-	-	-	-	-	0	14692	0	14692
		SUBTOTAL													112978	56975	286	170239
		CONTINGENCY					15 %	15 %	15 %						16947	8546	43	25536
36000	32	TOTAL													129925	65521	329	195775
36006	33	REPLACE CHILLER																
		CHILLER - CENTRIFUGAL, WATER-COOLED	275.0	1	1.00	TONS	244)(	102)(	0)	-	-	-	-	-	67100	28050	0	95150
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 6"	10	2	1.00	LF	2.25	3.52	-	1.10	1.61	1.10	100.0	70.5	50	80	0	130
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		START/DISCON, WYE-DELTA, OPEN, NEMA TYPE 1	251	1	1.00	HP	27.59	3.07	-	1.10	1.51	1.10	102.4	67.8	7800	789	0	8589
		MOTOR CONNECTION W/ FLEX CONDUIT, 250 HP	1	2	1.00	EA	103.00	193.00	-	1.10	1.50	1.10	102.4	67.8	232	393	0	625
		WIRE, TYPE THWN, COPPER, STRANDED, 400 MCM	70	4	1.00	LF	3.75	1.26	-	1.10	1.53	1.10	102.4	67.8	1183	366	0	1549
		CONDUIT, RIGID GALV STL, 3"	70	1	1.00	LF	8.60	8.55	-	1.10	1.53	1.10	102.4	67.8	678	621	0	1299
		DEMOLITION, CHILLER/PIPING/STARTER/CONDUIT	275.0	0.40	1.00	TONS	- (	102)	-	-	-	-	-	-	0	11220	0	11220
		SUBTOTAL													81235	45201	220	126656
		CONTINGENCY					15 %	15 %	15 %						12185	6780	33	18998
36006	33	TOTAL													93420	51981	253	145654
36006	33	ADDTL COST (EQUIP) TO RELOCATE PRIMARY CHILL WATER PUMP																
		RELOCATION, PUMP ASSEMBLY	1	1.60	1.00	LOT	-	3000	300	-	1.65	1.10	-	70.5	0	5584	528	6112
		SUBTOTAL													0	5584	528	6112
		CONTINGENCY					15 %	15 %	15 %						0	838	79	917
36006	33	TOTAL													0	6422	607	7029
36014	35	DEMOLISH ABANDONED CHILLER																
		DEMOLITION, CHILLER/PIPING/STARTER/CONDUIT	48.0	0.40	1.25	TONS	- (	134)	-	-	-	-	-	-	0	3216	0	3216
		SUBTOTAL													0	3216	0	3216
		CONTINGENCY					15 %	15 %	15 %						0	482	0	482
36014	35	TOTAL													0	3698	0	3698

APPENDIX I

Table I-4. ECO-1 Calculation of Construction Cost

PLANT BLDG NO	MASTER CHILLER NO	ITEM	QTY PER CHIL or 1-WAY RUN	QTY ADJUST FACTOR	LABOR DIFFIC ADJUST FACTOR	UNIT	UNIT BARE (TOT) MTL COST $/UNIT	UNIT BARE (TOT) LAB COST $/UNIT	UNIT BARE (TOT) EQP COST $/UNIT	MTL MARK UP %	LAB OH&P %	EQP MARK UP %	MTL COST ADJUST (AUSTIN) %	LAB COST ADJUST (AUSTIN) %	MTL COST $	LAB COST $	EQP COST $	TOTAL COST $
36014	35	ADDTL COST (EQUIP) TO DEMOLISH UNUSED COND WATER PUMP																
		DEMOLITION, PUMP/PIPING/STARTER/CONDUIT	1	0.40	1.00	LOT	-	2000	200	-	1.65	1.10	-	70.5	0	931	88	1019
		SUBTOTAL													0	931	88	1019
		CONTINGENCY					15 %	15 %	15 %						0	140	13	153
36014	35	TOTAL													0	1071	101	1172
36014	35	ADDTL COST (PIPING) TO DEMOLISH UNUSED CHILLER																
		DEMOLITION, PIPE, STL, SCH 40, WELD, 4"	60	0.40	1.00	LF	-	11.00	-	-	1.65	-	-	70.5	0	307	0	307
		SUBTOTAL													0	307	0	307
		CONTINGENCY					15 %	15 %	15 %						0	46	0	46
36014	35	TOTAL													0	353	0	353
36014	36	REPLACE CHILLER																
		CHILLER - RECIPROCATING, WATER-COOLED	96.2	1	1.25	TONS	243)(	77)(	5)	-	-	-	-	-	23377	9259	481	33117
		PIPE, STL, SCH 40, WELD, 4"	10	2	1.00	LF	9.45	11.00	1.38	1.10	1.65	1.10	100.0	70.5	208	256	30	494
		ELBOW, STL, STD WGHT, WELD, 4"	2	2	1.00	EA	17.15	81.50	10.25	1.10	1.66	1.10	100.0	70.5	75	382	45	502
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 4"	1	2	1.00	EA	360.00	51.00	-	1.10	1.55	1.10	100.0	70.5	792	111	0	903
		FLANGE, STL, 150 LB, WELD NECK, 4"	3	2	1.00	EA	24.00	41.00	5.10	1.10	1.65	1.10	100.0	70.5	158	286	34	478
		VALVE, IRON, BUTTERFLY, LUG, 4"	1	2	1.00	EA	92.00	81.50	-	1.10	1.52	1.10	100.0	70.5	202	175	0	377
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 4"	10	2	1.00	LF	1.95	2.77	-	1.10	1.61	1.10	100.0	70.5	43	63	0	106
		PIPE, STL, SCH 40, WELD, 4"	10	2	1.00	LF	9.45	11.00	1.38	1.10	1.65	1.10	100.0	70.5	208	256	30	494
		ELBOW, STL, STD WGHT, WELD, 4"	2	2	1.00	EA	17.15	81.50	10.25	1.10	1.66	1.10	100.0	70.5	75	382	45	502
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 4"	1	2	1.00	EA	360.00	51.00	-	1.10	1.55	1.10	100.0	70.5	792	111	0	903
		FLANGE, STL, 150 LB, WELD NECK, 4"	3	2	1.00	EA	24.00	41.00	5.10	1.10	1.65	1.10	100.0	70.5	158	286	34	478
		VALVE, IRON, BUTTERFLY, LUG, 4"	1	2	1.00	EA	92.00	81.50	-	1.10	1.52	1.10	100.0	70.5	202	175	0	377
		START/DISCON, WYE-DELTA, OPEN, NEMA TYPE 1	110	1	1.00	HP	28.95	5.69	-	1.10	1.51	1.10	102.4	67.8	3587	641	0	4228
		MOTOR CONNECTION W/ FLEX CONDUIT, 125 HP	1	2	1.00	EA	30.00	107.00	-	1.10	1.50	1.10	102.4	67.8	68	218	0	286
		WIRE, TYPE THWN, COPPER, STRANDED, 1/0	70	4	1.00	LF	1.14	0.65	-	1.10	1.50	1.10	102.4	67.8	360	184	0	544
		CONDUIT, RIGID GALV STL, 1-1/2"	70	1	1.00	LF	3.15	3.88	-	1.10	1.50	1.10	102.4	67.8	248	276	0	524
		DEMOLITION, CHILLER/PIPING/STARTER/CONDUIT	96.2	0.40	1.25	TONS	- (	77)	-	-	-	-	-	-	0	3704	0	3704
		SUBTOTAL													30553	16765	699	48017
		CONTINGENCY					15 %	15 %	15 %						4583	2515	105	7203
36014	36	TOTAL													35136	19280	804	55220
36014	36	ADDTL COST (EQUIP) TO RELOCATE COND WATER PUMP																
		DEMOLITION, PUMP/PIPING/STARTER/CONDUIT	1	0.40	1.00	LOT	-	2000	200	-	1.65	1.10	-	70.5	0	931	88	1019
		SUBTOTAL													0	931	88	1019
		CONTINGENCY					15 %	15 %	15 %						0	140	13	153
36014	36	TOTAL													0	1071	101	1172
36014	36	ADDTL COST (PIPING) TO RELOCATE CHILLER																
		PIPE, STL, SCH 40, WELD, 4"	20	2	1.00	LF	9.45	11.00	1.38	1.10	1.65	1.10	100.0	70.5	416	512	61	989
		ELBOW, STL, STD WGHT, WELD, 4"	4	2	1.00	EA	17.15	81.50	10.25	1.10	1.66	1.10	100.0	70.5	151	763	90	1004
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 4"	20	2	1.00	LF	1.95	2.77	-	1.10	1.61	1.10	100.0	70.5	86	126	0	212
		PIPE, STL, SCH 40, WELD, 4"	10	2	1.00	LF	9.45	11.00	1.38	1.10	1.65	1.10	100.0	70.5	208	256	30	494
		ELBOW, STL, STD WGHT, WELD, 4"	4	2	1.00	EA	17.15	81.50	10.25	1.10	1.66	1.10	100.0	70.5	151	763	90	1004
		SUBTOTAL													1012	2420	271	3703
		CONTINGENCY					15 %	15 %	15 %						152	363	41	556
36014	36	TOTAL													1164	2783	312	4259

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Table I-4. ECO-1 Calculation of Construction Cost

PLANT BLDG NO	MASTER CHILLER NO	ITEM	QTY PER CHIL or 1-WAY RUN	QTY ADJUST FACTOR	LABOR DIFFIC ADJUST FACTOR	UNIT	UNIT BARE (TOT) MTL COST $/UNIT	UNIT BARE (TOT) LAB COST $/UNIT	UNIT BARE (TOT) EQP COST $/UNIT	MTL MARK UP %	LAB OH&P %	EQP MARK UP %	MTL COST ADJUST (AUSTIN) %	LAB COST ADJUST (AUSTIN) %	MTL COST $	LAB COST $	EQP COST $	TOTAL COST $
39015	37 (38 SIM)	REPLACE (DOWNSIZE) CHILLER																
		CHILLER - CENTRIFUGAL, WATER-COOLED	490.0	1	1.00	TONS	204)(	76)(	0)	-	-	-	-	-	99960	37240	0	137200
		PIPE, STL, SCH 40, WELD, 8"	10	2	1.00	LF	28.00	22.00	1.76	1.10	1.62	1.10	100.0	70.5	616	503	39	1158
		ELBOW, STL, STD WGHT, WELD, 8"	2	2	1.00	EA	77.00	159.00	12.80	1.10	1.61	1.10	100.0	70.5	339	722	56	1117
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 8"	1	2	1.00	EA	495.00	81.50	-	1.10	1.54	1.10	100.0	70.5	1089	177	0	1266
		FLANGE, STL, 150 LB, WELD NECK, 8"	3	2	1.00	EA	64.00	90.50	7.30	1.10	1.6?	1.10	100.0	70.5	422	620	48	1090
		VALVE, IRON, BUTTERFLY, LUG, 8"	1	2	1.00	EA	215.00	141.00	-	1.10	1.51	1.10	100.0	70.5	473	300	0	773
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 8"	10	2	1.00	LF	2.82	4.30	-	1.10	1.60	1.10	100.0	70.5	62	97	0	159
		PIPE, STL, SCH 40, WELD, 8"	10	2	1.00	LF	28.00	22.00	1.76	1.10	1.62	1.10	100.0	70.5	616	503	39	1158
		ELBOW, STL, STD WGHT, WELD, 8"	2	2	1.00	EA	77.00	159.00	12.80	1.10	1.61	1.10	100.0	70.5	339	722	56	1117
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 8"	1	2	1.00	EA	495.00	81.50	-	1.10	1.54	1.10	100.0	70.5	1089	177	0	1266
		FLANGE, STL, 150 LB, WELD NECK, 8"	3	2	1.00	EA	64.00	90.50	7.30	1.10	1.62	1.10	100.0	70.5	422	620	48	1090
		VALVE, IRON, BUTTERFLY, LUG, 8"	1	2	1.00	EA	215.00	141.00	-	1.10	1.51	1.10	100.0	70.5	473	300	0	773
		START/DISCON, WYE-DELTA, OPEN, NEMA TYPE 1	389	1	1.00	HP	26.12	2.30	-	1.10	1.51	1.10	102.4	67.8	11445	916	0	12361
		MOTOR CONNECTION W/ FLEX CONDUIT, 200 HP	2	2	1.00	EA	79.00	142.00	-	1.10	1.50	1.10	102.4	67.8	356	578	0	934
		WIRE, TYPE THWN, COPPER, STRANDED, 250 MCM	70	8	1.00	LF	2.35	1.07	-	1.10	1.51	1.10	102.4	67.8	1482	613	0	2095
		CONDUIT, RIGID GALV STL, 2-1/2"	70	2	1.00	LF	6.70	6.10	-	1.10	1.50	1.10	102.4	67.8	1057	869	0	1926
		DEMOLITION, CHILLER/PIPING/STARTER/CONDUIT	607.5	0.40	1.00	TONS	- (	68)	-	-	-	-	-	-	0	16524	0	16524
		SUBTOTAL													120240	61481	286	182007
		CONTINGENCY					15 %	15 %	15 %						18036	9222	43	27301
39015	37 (38)	TOTAL													138276	70703	329	209308
39015	37 (38 SIM)	ADDTL COST (PIPING) TO RELOCATE CHILLER																
		PIPE, STL, SCH 40, WELD, 8"	10	2	1.00	LF	28.00	22.00	1.76	1.10	1.62	1.10	100.0	70.5	616	503	39	1158
		ELBOW, STL, STD WGHT, WELD, 8"	2	2	1.00	EA	77.00	159.00	12.80	1.10	1.61	1.10	100.0	70.5	339	722	56	1117
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 8"	10	2	1.00	LF	2.82	4.30	-	1.10	1.60	1.10	100.0	70.5	62	97	0	159
		PIPE, STL, SCH 40, WELD, 8"	10	2	1.00	LF	28.00	22.00	1.76	1.10	1.62	1.10	100.0	70.5	616	503	39	1158
		ELBOW, STL, STD WGHT, WELD, 8"	2	2	1.00	EA	77.00	159.00	12.80	1.10	1.61	1.10	100.0	70.5	339	722	56	1117
		SUBTOTAL													1972	2547	190	4709
		CONTINGENCY					15 %	15 %	15 %						296	382	29	707
39015	37 (38)	TOTAL													2268	2929	219	5416
39043	39 (40 SIM)	REPLACE CHILLER																
		CHILLER - CENTRIFUGAL, WATER-COOLED	560.0	1	1.00	TONS	193)(	71)(	0)	-	-	-	-	-	108080	39760	0	147840
		PIPE, STL, SCH 40, WELD, 8"	10	2	1.00	LF	28.00	22.00	1.76	1.10	1.62	1.10	100.0	70.5	616	503	39	1158
		ELBOW, STL, STD WGHT, WELD, 8"	2	2	1.00	EA	77.00	159.00	12.80	1.10	1.61	1.10	100.0	70.5	339	722	56	1117
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 8"	1	2	1.00	EA	495.00	81.50	-	1.10	1.54	1.10	100.0	70.5	1089	177	0	1266
		FLANGE, STL, 150 LB, WELD NECK, 8"	3	2	1:00	EA	64.00	90.50	7.30	1.10	1.62	1.10	100.0	70.5	422	620	48	1090
		VALVE, IRON, BUTTERFLY, LUG, 8"	1	2	1.00	EA	215.00	141.00	-	1.10	1.51	1.10	100.0	70.5	473	300	0	773
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 8"	10	2	1.00	LF	2.82	4.30	-	1.10	1.60	1.10	100.0	70.5	62	97	0	159
		PIPE, STL, SCH 40, WELD, 8"	10	2	1.00	LF	28.00	22.00	1.76	1.10	1.62	1.10	100.0	70.5	616	503	39	1158
		ELBOW, STL, STD WGHT, WELD, 8"	2	2	1.00	EA	77.00	159.00	12.80	1.10	1.61	1.10	100.0	70.5	339	722	56	1117
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 8"	1	2	1.00	EA	495.00	81.50	-	1.10	1.54	1.10	100.0	70.5	1089	177	0	1266
		FLANGE, STL, 150 LB, WELD NECK, 8"	3	2	1.00	EA	64.00	90.50	7.30	1.10	1.62	1.10	100.0	70.5	422	620	48	1090
		VALVE, IRON, BUTTERFLY, LUG, 8"	1	2	1.00	EA	215.00	141.00	-	1.10	1.51	1.10	100.0	70.5	473	300	0	773
		START/DISCON, WYE-DELTA, OPEN, NEMA TYPE 1	462	1	1.00	HP	25.72	2.11	-	1.10	1.51	1.10	102.4	67.8	13385	998	0	14383
		MOTOR CONNECTION W/ FLEX CONDUIT, 250 HP	2	2	1.00	EA	103.00	193.00	-	1.10	1.50	1.10	102.4	67.8	464	785	0	1249
		WIRE, TYPE THWN, COPPER, STRANDED, 350 MCM	70	8	1.00	LF	3.15	1.19	-	1.10	1.50	1.10	102.4	67.8	1987	678	0	2665
		CONDUIT, RIGID GALV STL, 3"	70	2	1.00	LF	8.60	8.55	-	1.10	1.53	1.10	102.4	67.8	1356	1242	0	2598
		DEMOLITION, CHILLER/PIPING/STARTER/CONDUIT	560.0	0.40	1.00	TONS	- (	71)	-	-	-	-	-	-	0	15904	0	15904
		SUBTOTAL													131212	64108	286	195606
		CONTINGENCY					15 %	15 %	15 %						19682	9616	43	29341
39043	39 (40)	TOTAL													150894	73724	329	224947

APPENDIX I

Table I-4. ECO-1 Calculation of Construction Cost

PLANT BLDG NO	MASTER CHILLER NO	ITEM	QTY PER CHIL or 1-WAY RUN	QTY ADJUST FACTOR	LABOR DIFFIC ADJUST FACTOR	UNIT	UNIT BARE (TOT) MTL COST $/UNIT	UNIT BARE (TOT) LAB COST $/UNIT	UNIT BARE (TOT) EQP COST $/UNIT	MTL MARK UP %	LAB OH&P %	EQP MARK UP %	MTL COST ADJUST (AUSTIN) %	LAB COST ADJUST (AUSTIN) %	MTL COST $	LAB COST $	EQP COST $	TOTAL COST $
41003	41	REPLACE CHILLER																
		CHILLER - CENTRIFUGAL, WATER-COOLED	227.5	1	1.00	TONS	263)(	112)(	0)	-	-	-	-	-	59833	25480	0	85313
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 6"	10	2	1.00	LF	2.25	3.52	-	1.10	1.61	1.10	100.0	70.5	50	80	0	130
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		START/DISCON, WYE-DELTA, OPEN, NEMA TYPE 1	211	1	1.00	HP	28.38	3.52	-	1.10	1.51	1.10	102.4	67.8	6745	760	0	7505
		MOTOR CONNECTION W/ FLEX CONDUIT, 250 HP	1	2	1.00	EA	103.00	193.00	-	1.10	1.50	1.10	102.4	67.8	232	393	0	625
		WIRE, TYPE THWN, COPPER, STRANDED, 300 MCM	70	4	1.00	LF	2.80	1.12	-	1.10	1.54	1.10	102.4	67.8	883	327	0	1210
		CONDUIT, RIGID GALV STL, 2-1/2"	70	1	1.00	LF	6.70	6.10	-	1.10	1.50	1.10	102.4	67.8	528	434	0	962
		DEMOLITION, CHILLER/PIPING/STARTER/CONDUIT	227.5	0.40	1.00	TONS	- (	112)	-	-	-	-	-	-	0	10192	0	10192
		SUBTOTAL													72463	41348	220	114031
		CONTINGENCY					15 %	15 %	15 %						10869	6202	33	17104
41003	41	TOTAL													83332	47550	253	131135
41003	41	ADDTL COST (PIPING) TO RELOCATE CHILLER																
		PIPE, STL, SCH 40, WELD, 6"	30	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	1221	1214	94	2529
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 6"	30	2	1.00	LF	2.25	3.52	-	1.10	1.61	1.10	100.0	70.5	149	240	0	389
		PIPE, STL, SCH 40, WELD, 6"	30	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	1221	1214	94	2529
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		SUBTOTAL													2951	3822	278	7051
		CONTINGENCY					15 %	15 %	15 %						443	573	42	1058
41003	41	TOTAL													3394	4395	320	8109
42000	42	REPLACE (DOWNSIZE) CHILLER																
		CHILLER - CENTRIFUGAL, WATER-COOLED	188.1	1	1.00	TONS	309)(	119)(	0)	-	-	-	-	-	58123	22384	0	80507
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 6"	10	2	1.00	LF	2.25	3.52	-	1.10	1.61	1.10	100.0	70.5	50	80	0	130
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		START/DISCON, WYE-DELTA, OPEN, NEMA TYPE 1	170	1	1.00	HP	29.20	3.98	-	1.10	1.51	1.10	102.4	67.8	5591	693	0	6284
		MOTOR CONNECTION W/ FLEX CONDUIT, 200 HP	1	2	1.00	EA	79.00	142.00	-	1.10	1.50	1.10	102.4	67.8	178	289	0	467
		WIRE, TYPE THWN, COPPER, STRANDED, 4/0	70	4	1.00	LF	2.00	0.97	-	1.10	1.49	1.10	102.4	67.8	631	274	0	905
		CONDUIT, RIGID GALV STL, 2"	70	1	1.00	LF	4.00	4.75	-	1.10	1.51	1.10	102.4	67.8	315	340	0	655
		DEMOLITION, CHILLER/PIPING/STARTER/CONDUIT	209.0	0.40	1.00	TONS	- (	116)	-	-	-	-	-	-	0	9698	0	9698
		SUBTOTAL													69080	37440	220	106740
		CONTINGENCY					15 %	15 %	15 %						10362	5616	33	16011
42000	42	TOTAL													79442	43056	253	122751

APPENDIX I

Table I-4. ECO-1 Calculation of Construction Cost

PLANT BLDG NO	MASTER CHILLER NO	ITEM	QTY PER CHIL or 1-WAY RUN	QTY ADJUST FACTOR	LABOR DIFFIC ADJUST FACTOR	UNIT	UNIT BARE (TOT) MTL COST $/UNIT	UNIT BARE (TOT) LAB COST $/UNIT	UNIT BARE (TOT) EQP COST $/UNIT	MTL MARK UP %	LAB OH&P %	EQP MARK UP %	MTL COST ADJUST (AUSTIN) %	LAB COST ADJUST (AUSTIN) %	MTL COST $	LAB COST $	EQP COST $	TOTAL COST $
42000	42	ADDTL COST (PIPING) TO CORRECT PIPING DEFICIENCIES																
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 6"	10	2	1.00	LF	2.25	3.52	-	1.10	1.61	1.10	100.0	70.5	50	80	0	130
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		SUBTOTAL													1224	2044	152	3420
		CONTINGENCY					15 %	15 %	15 %						184	307	23	514
42000	42	TOTAL													1408	2351	175	3934
50001	43	REPLACE CHILLER																
		CHILLER - CENTRIFUGAL, WATER-COOLED	129.2	1	1.00	TONS	402)(	128)(	0)	-	-	-	-	-	51938	16538	0	68476
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 6"	10	2	1.00	LF	2.25	3.52	-	1.10	1.61	1.10	100.0	70.5	50	80	0	130
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		START/DISCON, WYE-DELTA, OPEN, NEMA TYPE 1	117	1	1.00	HP	29.07	5.43	-	1.10	1.51	1.10	102.4	67.8	3831	650	0	4481
		MOTOR CONNECTION W/ FLEX CONDUIT, 125 HP	1	2	1.00	EA	30.00	107.00	-	1.10	1.50	1.10	102.4	67.8	68	218	0	286
		WIRE, TYPE THWN, COPPER, STRANDED, 2/0	70	4	1.00	LF	1.32	0.74	-	1.10	1.51	1.10	102.4	67.8	416	211	0	627
		CONDUIT, RIGID GALV STL, 2"	70	1	1.00	LF	4.00	4.75	-	1.10	1.51	1.10	102.4	67.8	315	340	0	655
		DEMOLITION, CHILLER/PIPING/STARTER/CONDUIT	129.2	0.40	1.00	TONS	- (	94)	-	-	-	-	-	-	0	4858	0	4858
		SUBTOTAL													60810	26577	220	87607
		CONTINGENCY					15 %	15 %	15 %						9122	3987	33	13142
50001	43	TOTAL													69932	30564	253	100749
50001	43	ADDTL COST (EQUIP) TO ADD COOLING TOWER																
		COOLING TOWER - OPEN, AXIAL FAN	129.2	1	1.00	TONS	50)(	6)	-	-	-	-	-	-	6460	775	0	7235
		CONCRETE FOUNDATION SUPPORT, 12"W x 36"H	12	2	1.00	LF	15.11	9.11	0.37	1.10	1.64	1.10	75.5	71.4	301	256	10	567
		CRANE, TRUCK MOUNTED, 12 TON	1	1	1.00	LIFT	-	-	-	-	-	-	-	-	-	125	400	525
		PIPE, STL, SCH 40, WELD, 6"	20	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	814	809	62	1685
		ELBOW, STL, STD WGHT, WELD, 6"	4	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	361	1153	90	1604
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		DISCONNECT SWITCH, NEMA 4, 460 V, 30 A (THRU 15 HP)	2	1	1.00	EA	115.00	69.00	-	1.10	1.50	1.10	102.4	67.8	259	140	0	399
		MOTOR STARTER, NEMA 1, 460 V, NEMA 0 (THRU 5 HP)	2	1	1.00	EA	145.00	93.00	-	1.10	1.50	1.10	102.4	67.8	327	189	0	516
		MOTOR CONNECTION W/ FLEX CONDUIT, 5 HP	2	1	1.00	EA	3.55	26.50	-	1.10	1.51	1.10	102.4	67.8	8	54	0	62
		WIRE, TYPE THWN, COPPER, STRANDED, #14 (THRU 5 HP)	100	4	1.00	LF	0.05	0.16	-	1.10	1.48	1.10	102.4	67.8	23	66	0	89
		CONDUIT, RIGID GALV STL, 1/2" (THRU 4-#10)	100	1	1.00	LF	1.20	2.37	-	1.10	1.50	1.10	102.4	67.8	135	241	0	376
		DEMOLITION, CONDENSER/PIPING/STARTER/CONDUIT	64.6	2.00	1.00	TONS	- (	7)	-	-	-	-	-	-	0	904	0	904
		SUBTOTAL													9262	5420	596	15278
		CONTINGENCY					15 %	15 %	15 %						1389	813	89	2291
50001	43	TOTAL													10651	6233	685	17569

APPENDIX I

Table I-4. ECO-1 Calculation of Construction Cost

PLANT BLDG NO	MASTER CHILLER NO	ITEM	QTY PER CHIL or 1-WAY RUN	QTY ADJUST FACTOR	LABOR DIFFIC ADJUST FACTOR	UNIT	UNIT BARE (TOT) MTL COST $/UNIT	UNIT BARE (TOT) LAB COST $/UNIT	UNIT BARE (TOT) EQP COST $/UNIT	MTL MARK UP %	LAB OH&P %	EQP MARK UP %	MTL COST ADJUST (AUSTIN) %	LAB COST ADJUST (AUSTIN) %	MTL COST $	LAB COST $	EQP COST $	TOTAL COST $
50001	43	ADDTL COST (EQUIP) TO ADD CONDENSER WATER PUMP																
		PUMP, END SUCTION, 372 GPM @ 30', 7.5 HP	1	1	1.00	EA	1600.00	255.00	-	1.10	1.53	1.10	100.0	70.5	1760	275	0	2035
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		REDUCER, STL, STD WGHT, WELD, 6"	1	2	1.00	EA	32.50	127.00	10.20	1.10	1.61	1.10	100.0	70.5	72	288	22	382
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	4	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	326	577	45	948
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		VALVE, IRON, SILENT CHECK, FLANGED, 150 LB, 6"	1	1	1.00	EA	530.00	127.00	-	1.10	1.55	1.10	100.0	70.5	583	139	0	722
		STRAINER, IRON, Y-TYPE, FLANGED, 125 LB, 6"	1	1	1.00	EA	350.00	211.00	-	1.10	1.52	1.10	100.0	70.5	385	226	0	611
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 6"	10	2	1.00	LF	2.25	3.52	-	1.10	1.61	1.10	100.0	70.5	50	80	0	130
		DISCONNECT SWITCH, NEMA 4, 460 V, 30 A (THRU 15 HP)	1	1	1.00	EA	115.00	69.00	-	1.10	1.50	1.10	102.4	67.8	130	70	0	200
		MOTOR STARTER, NEMA 1, 460 V, NEMA 1 (THRU 10 HP)	1	1	1.00	EA	165.00	134.00	-	1.10	1.52	1.10	102.4	67.8	186	138	0	324
		MOTOR CONNECTION W/ FLEX CONDUIT, 10 HP	1	1	1.00	EA	3.55	26.50	-	1.10	1.51	1.10	102.4	67.8	4	27	0	31
		WIRE, TYPE THWN, COPPER, STRANDED, #12 (THRU 7.5 HP)	50	4	1.00	LF	0.07	0.19	-	1.10	1.49	1.10	102.4	67.8	16	39	0	55
		CONDUIT, RIGID GALV STL, 1/2" (THRU 4-#10)	50	1	1.00	LF	1.20	2.37	-	1.10	1.50	1.10	102.4	67.8	68	121	0	189
		SUBTOTAL													5432	3389	143	8964
		CONTINGENCY					15 %	15 %	15 %						815	508	21	1344
50001	43	TOTAL													6247	3897	164	10308
50001	43	ADDTL COST (PIPING) TO CHANGE FROM AIR- TO WATER-COOLED																
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 6"	10	2	1.00	LF	2.25	3.52	-	1.10	1.61	1.10	100.0	70.5	50	80	0	130
		PIPE, STL, SCH 40, WELD, 6"	60	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	2442	2427	187	5056
		ELBOW, STL, STD WGHT, WELD, 6"	6	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	541	1730	135	2406
		DEMOLITION, PIPE, STL, SCH 40, WELD, 4" (CU REFRIG SIM)	100	0.40	1.00	LF	-	11.00	-	-	1.65	-	-	70.5	0	512	0	512
		SUBTOTAL													3620	5731	398	9749
		CONTINGENCY					15 %	15 %	15 %						543	860	60	1463
50001	43	TOTAL													4163	6591	458	11212
50004	44	REPLACE (COMBINE/DOWNSIZE) CHILLER(S)																
		CHILLER - CENTRIFUGAL, WATER-COOLED	306.0	1	1.00	TONS	241)(	98)(	0)	-	-	-	-	-	73746	29988	0	103734
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 6"	10	2	1.00	LF	2.25	3.52	-	1.10	1.61	1.10	100.0	70.5	50	80	0	130
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		START/DISCON, WYE-DELTA, OPEN, NEMA TYPE 1	266	1	1.00	HP	27.29	2.90	-	1.10	1.51	1.10	102.4	67.8	8177	790	0	8967
		MOTOR CONNECTION W/ FLEX CONDUIT, 150 HP	2	2	1.00	EA	47.00	119.00	-	1.10	1.50	1.10	102.4	67.8	212	484	0	696
		WIRE, TYPE THWN, COPPER, STRANDED, 2/0	70	8	1.00	LF	1.32	0.74	-	1.10	1.51	1.10	102.4	67.8	833	421	0	1254
		CONDUIT, RIGID GALV STL, 2"	70	2	1.00	LF	4.00	4.75	-	1.10	1.51	1.10	102.4	67.8	631	681	0	1312
		DEMOLITION, CHILLER/PIPING/STARTER/CONDUIT	125.0	0.40	1.00	TONS	(	128)	-	-	-	-	-	-	0	6400	0	6400
		SUBTOTAL													87841	42526	220	130587
		CONTINGENCY					15 %	15 %	15 %						13176	6379	33	19588
50004	44	TOTAL													101017	48905	253	150175

APPENDIX I

Table I-4. ECO-1 Calculation of Construction Cost

PLANT BLDG NO	MASTER CHILLER NO	ITEM	QTY PER CHIL or 1-WAY RUN	QTY ADJUST FACTOR	LABOR DIFFIC ADJUST FACTOR	UNIT	UNIT BARE (TOT) MTL COST $/UNIT	UNIT BARE (TOT) LAB COST $/UNIT	UNIT BARE (TOT) EQP COST $/UNIT	MTL MARK UP %	LAB OH&P %	EQP MARK UP %	MTL COST ADJUST (AUSTIN) %	LAB COST ADJUST (AUSTIN) %	MTL COST $	LAB COST $	EQP COST $	TOTAL COST $
50004	44	ADDTL COST (EQUIP) TO REPLACE (COMB/DOWNSIZE) PUMPS																
		PUMP, HOR SPLIT, 734 GPM @ 80', 25 HP	1	1	1.00	EA	2325.00	455.00	-	1.10	1.52	1.10	100.0	70.5	2558	488	0	3046
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		REDUCER, STL, STD WGHT, WELD, 6"	1	2	1.00	EA	32.50	127.00	10.20	1.10	1.61	1.10	100.0	70.5	72	288	22	382
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	4	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	326	577	45	948
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		VALVE, IRON, SILENT CHECK, FLANGED, 150 LB, 6"	1	1	1.00	EA	530.00	127.00	-	1.10	1.55	1.10	100.0	70.5	583	139	0	722
		STRAINER, IRON, Y-TYPE, FLANGED, 125 LB, 6"	1	1	1.00	EA	350.00	211.00	-	1.10	1.52	1.10	100.0	70.5	385	226	0	611
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 6"	10	2	1.00	LF	2.25	3.52	-	1.10	1.61	1.10	100.0	70.5	50	80	0	130
		DISCONNECT SWITCH, NEMA 4, 460 V, 60 A (THRU 30 HP)	1	1	1.00	EA	195.00	97.00	-	1.10	1.50	1.10	102.4	67.8	220	99	0	319
		MOTOR STARTER, NEMA 1, 460 V, NEMA 2 (THRU 25 HP)	1	1	1.00	EA	325.00	194.00	-	1.10	1.51	1.10	102.4	67.8	366	199	0	565
		MOTOR CONNECTION W/ FLEX CONDUIT, 25 HP	1	1	1.00	EA	5.70	35.50	-	1.10	1.51	1.10	102.4	67.8	6	36	0	42
		WIRE, TYPE THWN, COPPER, STRANDED, #6 (THRU 30 HP)	50	4	1.00	LF	0.26	0.33	-	1.10	1.50	1.10	102.4	67.8	59	67	0	126
		CONDUIT, RIGID GALV STL, 3/4" (THRU 4-#6)	50	1	1.00	LF	1.50	2.67	-	1.10	1.50	1.10	102.4	67.8	84	136	0	220
		DEMOLITION, PUMP/PIPING/STARTER/CONDUIT	1	0.40	1.00	LOT	-	2000	200	-	1.65	1.10	-	70.5	0	931	88	1019
		PUMP, HOR SPLIT, 881 GPM @ 50', 20 HP	1	1	1.00	EA	2225.00	455.00	-	1.10	1.54	1.10	100.0	70.5	2448	494	0	2942
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		REDUCER, STL, STD WGHT, WELD, 6"	1	2	1.00	EA	32.50	127.00	10.20	1.10	1.61	1.10	100.0	70.5	72	288	22	382
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	4	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	326	577	45	948
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		VALVE, IRON, SILENT CHECK, FLANGED, 150 LB, 6"	1	1	1.00	EA	530.00	127.00	-	1.10	1.55	1.10	100.0	70.5	583	139	0	722
		STRAINER, IRON, Y-TYPE, FLANGED, 125 LB, 6"	1	1	1.00	EA	350.00	211.00	-	1.10	1.52	1.10	100.0	70.5	385	226	0	611
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 6"	10	2	1.00	LF	2.25	3.52	-	1.10	1.61	1.10	100.0	70.5	50	80	0	130
		DISCONNECT SWITCH, NEMA 4, 460 V, 60 A (THRU 30 HP)	1	1	1.00	EA	195.00	97.00	-	1.10	1.50	1.10	102.4	67.8	220	99	0	319
		MOTOR STARTER, NEMA 1, 460 V, NEMA 2 (THRU 25 HP)	1	1	1.00	EA	325.00	194.00	-	1.10	1.51	1.10	102.4	67.8	366	199	0	565
		MOTOR CONNECTION W/ FLEX CONDUIT, 25 HP	1	1	1.00	EA	5.70	35.50	-	1.10	1.51	1.10	102.4	67.8	6	36	0	42
		WIRE, TYPE THWN, COPPER, STRANDED, #6 (THRU 30 HP)	50	4	1.00	LF	0.26	0.33	-	1.10	1.50	1.10	102.4	67.8	59	67	0	126
		CONDUIT, RIGID GALV STL, 3/4" (THRU 4-#6)	50	1	1.00	LF	1.50	2.67	-	1.10	1.50	1.10	102.4	67.8	84	136	0	220
		DEMOLITION, PUMP/PIPING/STARTER/CONDUIT	1	0.40	1.00	LOT	-	2500	250	-	1.65	1.10	-	70.5	0	1163	110	1273
		SUBTOTAL													13012	9588	484	23084
		CONTINGENCY					15 %	15 %	15 %						1952	1438	73	3463
50004	44	TOTAL													14964	11026	557	26547
50004	44	ADDTL COST (PIPING) TO RELOCATE (COMB/DOWNSIZE) CHILLER(S)																
		PIPE, STL, SCH 40, WELD, 6"	65	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	2646	2629	203	5478
		ELBOW, STL, STD WGHT, WELD, 6"	3	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	271	865	67	1203
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 6"	65	2	1.00	LF	2.25	3.52	-	1.10	1.61	1.10	100.0	70.5	322	519	0	841
		PIPE, STL, SCH 40, WELD, 6"	55	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	2239	2225	172	4636
		ELBOW, STL, STD WGHT, WELD, 6"	6	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	541	1730	135	2406
		DEMOLITION, PIPE, STL, SCH 40, WELD, 4"	300	0.40	1.00	LF	-	11.00	-	-	1.65	-	-	70.5	0	1535	0	1535
		DEMOLITION, PIPE, STL, SCH 40, WELD, 6"	200	0.40	1.00	LF	-	17.60	-	-	1.63	-	-	70.5	0	1618	0	1618
		SUBTOTAL													6019	11121	577	17717
		CONTINGENCY					15 %	15 %	15 %						903	1668	87	2658
50004	44	TOTAL													6922	12789	664	20375
50004	45 (46 SIM)	DEMOLISH CHILLER																
		DEMOLITION, CHILLER/PIPING/STARTER/CONDUIT	125.0	0.40	1.00	TONS	- (	128)	-	-	-	-	-	-	0	6400	0	6400
		SUBTOTAL													0	6400	0	6400
		CONTINGENCY					15 %	15 %	15 %						0	960	0	960
50004	45 (46)	TOTAL													0	7360	0	7360

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Table I-4. ECO-1 Calculation of Construction Cost

PLANT BLDG NO	MASTER CHILLER NO	ITEM	QTY PER CHIL or 1-WAY RUN	QTY ADJUST FACTOR	LABOR DIFFIC ADJUST FACTOR	UNIT	UNIT BARE (TOT) MTL COST $/UNIT	UNIT BARE (TOT) LAB COST $/UNIT	UNIT BARE (TOT) EQP COST $/UNIT	MTL MARK UP %	LAB OH&P %	EQP MARK UP %	MTL COST ADJUST (AUSTIN) %	LAB COST ADJUST (AUSTIN) %	MTL COST $	LAB COST $	EQP COST $	TOTAL COST $
50004	45 (46 SIM)	ADDTL COST (EQUIP) TO DEMOLISH CHILL & COND WATER PUMPS																
		DEMOLITION, PUMP/PIPING/STARTER/CONDUIT	1	0.40	1.00	LOT	-	2000	200	-	1.65	1.10	-	70.5	0	931	88	1019
		DEMOLITION, PUMP/PIPING/STARTER/CONDUIT	1	0.40	1.00	LOT	-	2500	250	-	1.65	1.10	-	70.5	0	1163	110	1273
		SUBTOTAL													0	2094	198	2292
		CONTINGENCY					15 %	15 %	15 %						0	314	30	344
50004	45 (46)	TOTAL													0	2408	228	2636
87018	47 (48 SIM)	REPLACE CHILLER																
		CHILLER - CENTRIFUGAL, WATER-COOLED	474.0	1	1.00	TONS	209)(	77)(	0)	-	-	-	-	-	99066	36498	0	135564
		PIPE, STL, SCH 40, WELD, 8"	10	2	1.00	LF	28.00	22.00	1.76	1.10	1.62	1.10	100.0	70.5	616	503	39	1158
		ELBOW, STL, STD WGHT, WELD, 8"	2	2	1.00	EA	77.00	159.00	12.80	1.10	1.61	1.10	100.0	70.5	339	722	56	1117
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 8"	1	2	1.00	EA	495.00	81.50	-	1.10	1.54	1.10	100.0	70.5	1089	177	0	1266
		FLANGE, STL, 150 LB, WELD NECK, 8"	3	2	1.00	EA	64.00	90.50	7.30	1.10	1.62	1.10	100.0	70.5	422	620	48	1090
		VALVE, IRON, BUTTERFLY, LUG, 8"	1	2	1.00	EA	215.00	141.00	-	1.10	1.51	1.10	100.0	70.5	473	300	0	773
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 8"	10	2	1.00	LF	2.82	4.30	-	1.10	1.60	1.10	100.0	70.5	62	97	0	159
		PIPE, STL, SCH 40, WELD, 8"	10	2	1.00	LF	28.00	22.00	1.76	1.10	1.62	1.10	100.0	70.5	616	503	39	1158
		ELBOW, STL, STD WGHT, WELD, 8"	2	2	1.00	EA	77.00	159.00	12.80	1.10	1.61	1.10	100.0	70.5	339	722	56	1117
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 8"	1	2	1.00	EA	495.00	81.50	-	1.10	1.54	1.10	100.0	70.5	1089	177	0	1266
		FLANGE, STL, 150 LB, WELD NECK, 8"	3	2	1.00	EA	64.00	90.50	7.30	1.10	1.62	1.10	100.0	70.5	422	620	48	1090
		VALVE, IRON, BUTTERFLY, LUG, 8"	1	2	1.00	EA	215.00	141.00	-	1.10	1.51	1.10	100.0	70.5	473	300	0	773
		START/DISCON, WYE-DELTA, OPEN, NEMA TYPE 1	375	1	1.00	HP	26.20	2.33	-	1.10	1.51	1.10	102.4	67.8	11067	895	0	11962
		MOTOR CONNECTION W/ FLEX CONDUIT, 200 HP	2	2	1.00	EA	79.00	142.00	-	1.10	1.50	1.10	102.4	67.8	356	578	0	934
		WIRE, TYPE THWN, COPPER, STRANDED, 250 MCM	70	8	1.00	LF	2.35	1.07	-	1.10	1.51	1.10	102.4	67.8	1482	613	0	2095
		CONDUIT, RIGID GALV STL, 2-1/2"	70	2	1.00	LF	6.70	6.10	-	1.10	1.50	1.10	102.4	67.8	1057	869	0	1926
		DEMOLITION, CHILLER/PIPING/STARTER/CONDUIT	474.0	0.40	1.00	TONS	- (	77)	-	-	-	-	-	-	0	14599	0	14599
		SUBTOTAL													118968	58793	286	178047
		CONTINGENCY					15 %	15 %	15 %						17845	8819	43	26707
87018	47 (48)	TOTAL													136813	67612	329	204754
91001	49	REPLACE CHILLER																
		CHILLER - RECIPROCATING, WATER-COOLED	121.8	1	1.25	TONS	419)(	128)(	0)	-	-	-	-	-	51034	19488	0	70522
		PIPE, STL, SCH 40, WELD, 4"	10	2	1.00	LF	9.45	11.00	1.38	1.10	1.65	1.10	100.0	70.5	208	256	30	494
		ELBOW, STL, STD WGHT, WELD, 4"	2	2	1.00	EA	17.15	81.50	10.25	1.10	1.66	1.10	100.0	70.5	75	382	45	502
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 4"	1	2	1.00	EA	360.00	51.00	-	1.10	1.55	1.10	100.0	70.5	792	111	0	903
		FLANGE, STL, 150 LB, WELD NECK, 4"	3	2	1.00	EA	24.00	41.00	5.10	1.10	1.65	1.10	100.0	70.5	158	286	34	478
		VALVE, IRON, BUTTERFLY, LUG, 4"	1	2	1.00	EA	92.00	81.50	-	1.10	1.52	1.10	100.0	70.5	202	175	0	377
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 4"	10	2	1.00	LF	1.95	2.77	-	1.10	1.61	1.10	100.0	70.5	43	63	0	106
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		START/DISCON, WYE-DELTA, OPEN, NEMA TYPE 1	112	1	1.00	HP	28.99	5.62	-	1.10	1.51	1.10	102.4	67.8	3657	644	0	4301
		MOTOR CONNECTION W/ FLEX CONDUIT, 125 HP	1	2	1.00	EA	30.00	107.00	-	1.10	1.50	1.10	102.4	67.8	68	218	0	286
		WIRE, TYPE THWN, COPPER, STRANDED, 1/0	70	4	1.00	LF	1.14	0.65	-	1.10	1.50	1.10	102.4	67.8	360	184	0	544
		CONDUIT, RIGID GALV STL, 1-1/2"	70	1	1.00	LF	3.15	3.88	-	1.10	1.50	1.10	102.4	67.8	248	276	0	524
		DEMOLITION, CHILLER/PIPING/STARTER/CONDUIT	121.8	0.40	1.25	TONS	- (	93)	-	-	-	-	-	-	0	5664	0	5664
		SUBTOTAL													58941	29588	219	88748
		CONTINGENCY					15 %	15 %	15 %						8841	4438	33	13312
91001	49	TOTAL													67782	34026	252	102060

APPENDIX I

Table I-4. ECO-1 Calculation of Construction Cost

PLANT BLDG NO	MASTER CHILLER NO	ITEM	QTY PER CHIL or 1-WAY RUN	QTY ADJUST FACTOR	LABOR DIFFIC ADJUST FACTOR	UNIT	UNIT BARE (TOT) MTL COST $/UNIT	UNIT BARE (TOT) LAB COST $/UNIT	UNIT BARE (TOT) EQP COST $/UNIT	MTL MARK UP %	LAB OH&P %	EQP MARK UP %	MTL COST ADJUST (AUSTIN) %	LAB COST ADJUST (AUSTIN) %	MTL COST $	LAB COST $	EQP COST $	TOTAL COST $
91001	49	ADDTL COST (EQUIP) TO ADD COOLING TOWER																
		COOLING TOWER - OPEN, AXIAL FAN	121.8	1	1.00	TONS	53)(	6)	-	-	-	-	-	-	6455	731	0	7186
		CONCRETE FOUNDATION SUPPORT, 12"W x 36"H	12	2	1.00	LF	15.11	9.11	0.37	1.10	1.64	1.10	75.5	71.4	301	256	10	567
		CRANE, TRUCK MOUNTED, 12 TON	1	1	1.00	LIFT	-	-	-	-	-	-	-	-	-	125	400	525
		PIPE, STL, SCH 40, WELD, 6"	20	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	814	809	62	1685
		ELBOW, STL, STD WGHT, WELD, 6"	4	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	361	1153	90	1604
		FLANGE, STL, 150 LB, WELD NECK, 6"	3	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	244	432	34	710
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		DISCONNECT SWITCH, NEMA 4, 460 V, 30 A (THRU 15 HP)	2	1	1.00	EA	115.00	69.00	-	1.10	1.50	1.10	102.4	67.8	259	140	0	399
		MOTOR STARTER, NEMA 1, 460 V, NEMA 0 (THRU 5 HP)	2	1	1.00	EA	145.00	93.00	-	1.10	1.50	1.10	102.4	67.8	327	189	0	516
		MOTOR CONNECTION W/ FLEX CONDUIT, 5 HP	2	1	1.00	EA	3.55	26.50	-	1.10	1.51	1.10	102.4	67.8	8	54	0	62
		WIRE, TYPE THWN, COPPER, STRANDED, #14 (THRU 5 HP)	100	4	1.00	LF	0.05	0.16	-	1.10	1.48	1.10	102.4	67.8	23	66	0	89
		CONDUIT, RIGID GALV STL, 1/2" (THRU 4-#10)	100	1	1.00	LF	1.20	2.37	-	1.10	1.50	1.10	102.4	67.8	135	241	0	376
		DEMOLITION, COOLING TOWER/PIPING/STARTER/CONDUIT	121.8	1.00	1.00	TONS	- (	6)	-	-	-	-	-	-	0	731	0	731
		SUBTOTAL													9257	5203	596	15056
		CONTINGENCY					15 %	15 %	15 %						1389	780	89	2258
91001	49	TOTAL													10646	5983	685	17314
91001	49	ADDTL COST (EQUIP) TO ADD COND WATER PUMP																
		PUMP, END SUCTION, 351 GPM @ 30', 7.5 HP	1	1	1.00	EA	1600.00	255.00	-	1.10	1.53	1.10	100.0	70.5	1760	275	0	2035
		PIPE, STL, SCH 40, WELD, 6"	10	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	407	405	31	843
		ELBOW, STL, STD WGHT, WELD, 6"	2	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	180	577	45	802
		REDUCER, STL, STD WGHT, WELD, 6"	1	2	1.00	EA	32.50	127.00	10.20	1.10	1.61	1.10	100.0	70.5	72	288	22	382
		FLEX CONN, TWIN-SHERE NEOPRENE, FLANGED, 6"	1	2	1.00	EA	425.00	68.00	-	1.10	1.58	1.10	100.0	70.5	935	151	0	1086
		FLANGE, STL, 150 LB, WELD NECK, 6"	4	2	1.00	EA	37.00	63.50	5.10	1.10	1.61	1.10	100.0	70.5	326	577	45	948
		VALVE, IRON, BUTTERFLY, LUG, 6"	1	2	1.00	EA	150.00	127.00	-	1.10	1.54	1.10	100.0	70.5	330	276	0	606
		VALVE, IRON, SILENT CHECK, FLANGED, 150 LB, 6"	1	1	1.00	EA	530.00	127.00	-	1.10	1.55	1.10	100.0	70.5	583	139	0	722
		STRAINER, IRON, Y-TYPE, FLANGED, 125 LB, 6"	1	1	1.00	EA	350.00	211.00	-	1.10	1.52	1.10	100.0	70.5	385	226	0	611
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 6"	10	2	1.00	LF	2.25	3.52	-	1.10	1.61	1.10	100.0	70.5	50	80	0	130
		DISCONNECT SWITCH, NEMA 4, 460 V, 30 A (THRU 15 HP)	1	1	1.00	EA	115.00	69.00	-	1.10	1.50	1.10	102.4	67.8	130	70	0	200
		MOTOR STARTER, NEMA 1, 460 V, NEMA 1 (THRU 10 HP)	1	1	1.00	EA	165.00	134.00	-	1.10	1.52	1.10	102.4	67.8	186	138	0	324
		MOTOR CONNECTION W/ FLEX CONDUIT, 10 HP	1	1	1.00	EA	3.55	26.50	-	1.10	1.51	1.10	102.4	67.8	4	27	0	31
		WIRE, TYPE THWN, COPPER, STRANDED, #12 (THRU 7.5 HP)	50	4	1.00	LF	0.07	0.19	-	1.10	1.49	1.10	102.4	67.8	16	39	0	55
		CONDUIT, RIGID GALV STL, 1/2" (THRU 4-#10)	50	1	1.00	LF	1.20	2.37	-	1.10	1.50	1.10	102.4	67.8	68	121	0	189
		SUBTOTAL													5432	3389	143	8964
		CONTINGENCY					15 %	15 %	15 %						815	508	21	1344
91001	49	TOTAL													6247	3897	164	10308
91001	49	ADDTL COST (PIPING) TO CHANGE FROM AIR- TO WATER-COOLED																
		PIPE, STL, SCH 40, WELD, 4"	30	2	1.00	LF	9.45	11.00	1.38	1.10	1.65	1.10	100.0	70.5	624	768	91	1483
		ELBOW, STL, STD WGHT, WELD, 4"	5	2	1.00	EA	17.15	81.50	10.25	1.10	1.66	1.10	100.0	70.5	189	954	113	1256
		INSUL, FIBERGLASS, ASJ, 1-1/2" THK, 4"	30	2	1.00	LF	1.95	2.77	-	1.10	1.61	1.10	100.0	70.5	129	189	0	318
		PIPE, STL, SCH 40, WELD, 6"	65	2	1.00	LF	18.50	17.60	1.42	1.10	1.63	1.10	100.0	70.5	2646	2629	203	5478
		ELBOW, STL, STD WGHT, WELD, 6"	12	2	1.00	EA	41.00	127.00	10.20	1.10	1.61	1.10	100.0	70.5	1082	3460	269	4811
		SUBTOTAL													4670	8000	676	13346
		CONTINGENCY					15 %	15 %	15 %						701	1200	101	2002
91001	49	TOTAL													5371	9200	777	15348

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Table I-5. Calculation of Cost to Upgrade Mechanical Rooms

PLANT BLDG NO	ITEM	DESCRIPTION	UNIT	UNIT COST	COST ADJUST (AUSTIN)	QTY	TOTAL COST
121	1	FOUNDATIONS					
		FOUNDATION & FOOTINGS	SF	7.20	0.884	198	1260
		EXCAVATION & BACKFILL	SF	1.59	0.884	198	278
	2	SUBSTRUCTURE					
		6" SLAB ON GRADE, GRAV, VAP BAR	SF	6.03	0.884	198	1055
		DEMOLISH HOUSEKEEPING PAD	SF	2.19	0.884	30	58
	3	SUPERSTRUCTURE					
		STEEL FRAMING	SF	4.10	0.936	198	760
		ROOF, OPEN WEB JOIST, STL DECK	SF	2.93	0.936	198	543
	4	EXTERIOR CLOSURE					
		CONCRETE BLOCK WALL, PTD	SF	9.83	0.812	598	4773
	5	ROOFING					
		TAR & GRAVEL W/ INSULATION	SF	3.36	0.789	198	525
	6	INTERIOR					
		HOLLOW METAL DOOR, 1-HR	EA	1059	0.918	2	1944
		PARTITION, STL STUD / GYP, 1-HR, PTD	SF	4.13	0.818	0	0
	7	MECHANICAL VENTILATION					
		EXHAUST FAN, ROOF CENTRIFUGAL	EA	1500	0.874	1	1311
		INTAKE LOUVER	SF	41	0.874	7.5	269
		DUCT DAMPER, 24x16	EA	93	0.874	1	81
		DUCTWORK	LB	6.10	0.874	110	586
		REVISE DUCTWORK	LB	6.10	0.874	172	917
		RELOCATE LOUVER	SF	16	0.874	25	350
	8	CONTROLS					
		DAMPER ACTUATOR, 120V-1PH	EA	259	0.874	1	226
		THERMOSTAT, 120V-1PH	EA	65	0.874	1	57
		REFRIGERATION SENSOR/ALARM	EA	1200	0.874	1	1049
	9	ELECTRICAL					
		WIRE & CONDUIT, 1/2 HP FAN MOTOR	EA	790	0.787	1	622
		EMERG SHUT-DOWN & VENT SWITCHES	EA	147	0.787	2	231
		LIGHTS & RECEPTACLES	SF	2.60	0.787	198	405
							17300
				CONTINGENCY			1.20
COMMENTS:				TOTAL			20760

1. REFRIGERANT = 650# OF R-11 / MECH ROOM @ GROUND LEVEL
2. CHILLER IN ROOM WITH GAS WATER HEATERS AND AIR-HANDLING UNIT
3. VERY DIFFICULT TO ISOLATE THE CHILLER
4. RECOMMEND EXTENDING MECH ROOM 8' x 31' AND LEAVING PUMPS IN PRESENT LOCATION

PLANT BLDG NO	ITEM	DESCRIPTION	UNIT	UNIT COST	COST ADJUST (AUSTIN)	QTY	TOTAL COST
135	1	FOUNDATIONS					
		FOUNDATION & FOOTINGS	SF	7.20	0.884	0	0
		EXCAVATION & BACKFILL	SF	1.59	0.884	0	0
	2	SUBSTRUCTURE					
		6" SLAB ON GRADE, GRAV, VAP BAR	SF	6.03	0.884	0	0
		DEMOLISH HOUSEKEEPING PAD	SF	2.19	0.884	0	0
	3	SUPERSTRUCTURE					
		STEEL FRAMING	SF	4.10	0.936	0	0
		ROOF, OPEN WEB JOIST, STL DECK	SF	2.93	0.936	0	0
	4	EXTERIOR CLOSURE					
		CONCRETE BLOCK WALL, PTD	SF	9.83	0.812	0	0
	5	ROOFING					
		TAR & GRAVEL W/ INSULATION	SF	3.36	0.789	0	0
	6	INTERIOR					
		HOLLOW METAL DOOR, 1-HR	EA	1059	0.918	1	972
		PARTITION, STL STUD / GYP, 1-HR, PTD	SF	4.13	0.818	235	794
	7	MECHANICAL VENTILATION					
		EXHAUST FAN, ROOF CENTRIFUGAL	EA	1500	0.874	1	1311
		INTAKE LOUVER	SF	41	0.874	7.5	269
		DUCT DAMPER, 24x16	EA	93	0.874	1	81
		DUCTWORK	LB	6.10	0.874	110	586
		REVISE DUCTWORK	LB	6.10	0.874	0	0
		RELOCATE LOUVER	SF	16	0.874	0	0
	8	CONTROLS					
		DAMPER ACTUATOR, 120V-1PH	EA	259	0.874	1	226
		THERMOSTAT, 120V-1PH	EA	65	0.874	1	57
		REFRIGERATION SENSOR/ALARM	EA	1200	0.874	1	1049
	9	ELECTRICAL					
		WIRE & CONDUIT, 1/2 HP FAN MOTOR	EA	790	0.787	1	622
		EMERG SHUT-DOWN & VENT SWITCHES	EA	147	0.787	2	231
		LIGHTS & RECEPTACLES	SF	2.60	0.787	0	0
							6198
				CONTINGENCY			1.20
COMMENTS:				TOTAL			7438

1. REFRIGERANT = 405# OF R-12 & 400# OF R-22 / MECH ROOM IN BASEMENT
2. TWO CHILLERS IN ROOM WITH GAS WATER HEATERS AND AIR-HANDLING UNIT
3. FAIRLY SIMPLE TO ISOLATE THE CHILLERS, ESPECIALLY WHEN THE TWO WILL BE REPLACED WITH A SINGLE CHILLER. ALSO CONSIDER PICK UP LOAD OF AIR-COOLED UNIT AT OTHER END OF BLDG.
4. ALSO REPLACE TWO COOLING TOWERS WITH ONE

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Table I-5. Calculation of Cost to Upgrade Mechanical Rooms

PLANT BLDG NO	ITEM	DESCRIPTION	UNIT	UNIT COST	COST ADJUST (AUSTIN)	QTY	TOTAL COST
194	1	FOUNDATIONS					
		FOUNDATION & FOOTINGS	SF	7.20	0.884	0	0
		EXCAVATION & BACKFILL	SF	1.59	0.884	0	0
	2	SUBSTRUCTURE					
		6" SLAB ON GRADE, GRAV, VAP BAR	SF	6.03	0.884	0	0
		DEMOLISH HOUSEKEEPING PAD	SF	2.19	0.884	0	0
	3	SUPERSTRUCTURE					
		STEEL FRAMING	SF	4.10	0.936	0	0
		ROOF, OPEN WEB JOIST, STL DECK	SF	2.93	0.936	0	0
	4	EXTERIOR CLOSURE					
		CONCRETE BLOCK WALL, PTD	SF	9.83	0.812	0	0
	5	ROOFING					
		TAR & GRAVEL W/ INSULATION	SF	3.36	0.789	0	0
	6	INTERIOR					
		HOLLOW METAL DOOR, 1-HR	EA	1059	0.918	2	1944
		PARTITION, STL STUD / GYP, 1-HR, PTD	SF	4.13	0.818	574	1939
	7	MECHANICAL VENTILATION					
		EXHAUST FAN, WALL MOUNTED PROP	EA	1500	0.874	1	1311
		INTAKE LOUVER	SF	41	0.874	0	0
		DUCT DAMPER, 24x18	EA	93	0.874	1	81
		DUCTWORK	LB	6.10	0.874	288	1535
		REVISE DUCTWORK	LB	6.10	0.874	0	0
		RELOCATE LOUVER	SF	16	0.874	0	0
	8	CONTROLS					
		DAMPER ACTUATOR, 120V-1PH	EA	259	0.874	1	226
		THERMOSTAT, 120V-1PH	EA	65	0.874	1	57
		REFRIGERATION SENSOR/ALARM	EA	1200	0.874	1	1049
		9 ELECTRICAL					
		WIRE & CONDUIT, 1/2 HP FAN MOTOR	EA	790	0.787	1	622
		EMERG SHUT-DOWN & VENT SWITCHES	EA	147	0.787	2	231
		LIGHTS & RECEPTACLES	SF	2.60	0.787	0	0
							8995
				CONTINGENCY			1.20
				TOTAL			10794

COMMENTS:

1. REFRIGERANT = 680# OF R-12 / MECH ROOM IN BASEMENT
2. CHILLER IN ROOM WITH GAS-FIRED BOILER
3. FAIRLY SIMPLE TO ISOLATE THE CHILLER

PLANT BLDG NO	ITEM	DESCRIPTION	UNIT	UNIT COST	COST ADJUST (AUSTIN)	QTY	TOTAL COST
410	1	FOUNDATIONS					
		FOUNDATION & FOOTINGS	SF	7.20	0.884	0	0
		EXCAVATION & BACKFILL	SF	1.59	0.884	0	0
	2	SUBSTRUCTURE					
		6" SLAB ON GRADE, GRAV, VAP BAR	SF	6.03	0.884	0	0
		DEMOLISH HOUSEKEEPING PAD	SF	2.19	0.884	0	0
	3	SUPERSTRUCTURE					
		STEEL FRAMING	SF	4.10	0.936	0	0
		ROOF, OPEN WEB JOIST, STL DECK	SF	2.93	0.936	0	0
	4	EXTERIOR CLOSURE					
		CONCRETE BLOCK WALL, PTD	SF	9.83	0.812	0	0
	5	ROOFING					
		TAR & GRAVEL W/ INSULATION	SF	3.36	0.789	0	0
	6	INTERIOR					
		HOLLOW METAL DOOR, 1-HR	EA	1059	0.918	2	1944
		PARTITION, STL STUD / GYP, 1-HR, PTD	SF	4.13	0.818	240	811
	7	MECHANICAL VENTILATION					
		EXHAUST FAN, ROOF CENTRIFUGAL	EA	1500	0.874	1	1311
		INTAKE LOUVER	SF	41	0.874	9.3	333
		DUCT DAMPER, 24x18	EA	93	0.874	1	81
		DUCTWORK	LB	6.10	0.874	120	640
		REVISE DUCTWORK	LB	6.10	0.874	270	1439
		RELOCATE LOUVER	SF	16	0.874	16	224
	8	CONTROLS					
		DAMPER ACTUATOR, 120V-1PH	EA	259	0.874	1	226
		THERMOSTAT, 120V-1PH	EA	65	0.874	1	57
		REFRIGERATION SENSOR/ALARM	EA	1200	0.874	1	1049
	9	ELECTRICAL					
		WIRE & CONDUIT, 1/2 HP FAN MOTOR	EA	790	0.787	1	622
		EMERG SHUT-DOWN & VENT SWITCHES	EA	147	0.787	2	231
		LIGHTS & RECEPTACLES	SF	2.60	0.787	0	0
							8968
				CONTINGENCY			1.20
				TOTAL			10762

COMMENTS:

1. REFRIGERANT = 1214# OF R-12 / MECH ROOM BELOW GRADE
2. TWO CHILLERS IN ROOM WITH GAS-FIRED BOILER AND WATER HEATERS
3. VERY EASY TO ISOLATE THE CHILLER
4. WATCH TUBE-PULL CLEARANCES AND WALL/FLUE HEADER CONFLICTS

APPENDIX I

Table I-5. Calculation of Cost to Upgrade Mechanical Rooms

PLANT BLDG NO	ITEM	DESCRIPTION	UNIT	UNIT COST	COST ADJUST (AUSTIN)	QTY	TOTAL COST
2805	1	FOUNDATIONS					
		FOUNDATION & FOOTINGS	SF	7.20	0.884	160	1018
		EXCAVATION & BACKFILL	SF	1.59	0.884	160	225
	2	SUBSTRUCTURE					
		6" SLAB ON GRADE, GRAV, VAP BAR	SF	6.03	0.884	160	853
		DEMOLISH HOUSEKEEPING PAD	SF	2.19	0.884	42	81
	3	SUPERSTRUCTURE					
		STEEL FRAMING	SF	4.10	0.936	160	614
		ROOF, OPEN WEB JOIST, STL DECK	SF	2.93	0.936	160	439
	4	EXTERIOR CLOSURE					
		CONCRETE BLOCK WALL, PTD	SF	9.83	0.812	218	1740
	5	ROOFING					
		TAR & GRAVEL W/ INSULATION	SF	3.36	0.789	160	424
	6	INTERIOR					
		HOLLOW METAL DOOR, 1-HR	EA	1059	0.918	2	1944
		PARTITION, STL STUD / GYP, 1-HR, PTD	SF	4.13	0.818	150	507
	7	MECHANICAL VENTILATION					
		EXHAUST FAN, ROOF CENTRIFUGAL	EA	1025	0.874	1	896
		INTAKE LOUVER	SF	41	0.874	5.5	197
		DUCT DAMPER, 20x18	EA	77	0.874	1	67
		DUCTWORK	LB	6.10	0.874	100	533
		REVISE DUCTWORK	LB	6.10	0.874	0	0
		RELOCATE LOUVER	SF	18	0.874	0	0
	8	CONTROLS					
		DAMPER ACTUATOR, 120V-1PH	EA	259	0.874	1	226
		THERMOSTAT, 120V-1PH	EA	65	0.874	1	57
		REFRIGERATION SENSOR/ALARM	EA	1200	0.874	1	1049
	9	ELECTRICAL					
		WIRE & CONDUIT, 1/3 HP FAN MOTOR	EA	775	0.787	1	610
		EMERG SHUT-DOWN & VENT SWITCHES	EA	147	0.787	2	231
		LIGHTS & RECEPTACLES	SF	2.60	0.787	160	327
							12038
				CONTINGENCY			1.20
COMMENTS:				TOTAL			14446

1. REFRIGERANT = 415# OF R-113 / MECH ROOM @ GROUND LEVEL
2. CHILLER IN ROOM WITH GAS-FIRED BOILER AND AIR-HANDLING UNIT
3. FAIRLY SIMPLE TO ISOLATE THE CHILLER
4. RECOMMEND EXTENDING MECH ROOM 10' AND MOVING DOUBLE DOORS TO ALLOW TUBE PULL

PLANT BLDG NO	ITEM	DESCRIPTION	UNIT	UNIT COST	COST ADJUST (AUSTIN)	QTY	TOTAL COST
5764	1	FOUNDATIONS					
		FOUNDATION & FOOTINGS	SF	7.20	0.884	0	0
		EXCAVATION & BACKFILL	SF	1.59	0.884	0	0
	2	SUBSTRUCTURE					
		6" SLAB ON GRADE, GRAV, VAP BAR	SF	6.03	0.884	0	0
		DEMOLISH HOUSEKEEPING PAD	SF	2.19	0.884	0	0
	3	SUPERSTRUCTURE					
		STEEL FRAMING	SF	4.10	0.936	0	0
		ROOF, OPEN WEB JOIST, STL DECK	SF	2.93	0.936	0	0
	4	EXTERIOR CLOSURE					
		CONCRETE BLOCK WALL, PTD	SF	9.83	0.812	0	0
	5	ROOFING					
		TAR & GRAVEL W/ INSULATION	SF	3.36	0.789	0	0
	6	INTERIOR					
		HOLLOW METAL DOOR, 1-HR	EA	1059	0.918	1	972
		PARTITION, STL STUD / GYP, 1-HR, PTD	SF	4.13	0.818	267	902
	7	MECHANICAL VENTILATION					
		EXHAUST FAN, ROOF CENTRIFUGAL	EA	1025	0.874	1	896
		INTAKE LOUVER	SF	41	0.874	5.5	197
		DUCT DAMPER, 20x18	EA	77	0.874	1	67
		DUCTWORK	LB	6.10	0.874	100	533
		REVISE DUCTWORK	LB	6.10	0.874	0	0
		RELOCATE LOUVER	SF	18	0.874	0	0
	8	CONTROLS					
		DAMPER ACTUATOR, 120V-1PH	EA	259	0.874	1	226
		THERMOSTAT, 120V-1PH	EA	65	0.874	1	57
		REFRIGERATION SENSOR/ALARM	EA	1200	0.874	1	1049
	9	ELECTRICAL					
		WIRE & CONDUIT, 1/3 HP FAN MOTOR	EA	775	0.787	1	610
		EMERG SHUT-DOWN & VENT SWITCHES	EA	147	0.787	2	231
		LIGHTS & RECEPTACLES	SF	2.60	0.787	0	0
							5740
				CONTINGENCY			1.20
COMMENTS:				TOTAL			6888

1. REFRIGERANT = 485# OF R-113 / MECH ROOM IN BASEMENT
2. CHILLER IN ROOM WITH GAS-FIRED BOILER AND WATER HEATERS
3. FAIRLY SIMPLE TO ISOLATE THE CHILLER
4. ALSO PICK UP LOAD FROM AN OUTDOOR AIR COOLED CHILLER WHEN MAIN CHILLER IS REPLACED

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Table I-5. Calculation of Cost to Upgrade Mechanical Rooms

PLANT BLDG NO	ITEM	DESCRIPTION	UNIT	UNIT COST	COST ADJUST (AUSTIN)	QTY	TOTAL COST
5792	1	FOUNDATIONS					
		FOUNDATION & FOOTINGS	SF	7.20	0.884	0	0
		EXCAVATION & BACKFILL	SF	1.59	0.884	0	0
	2	SUBSTRUCTURE					
		6" SLAB ON GRADE, GRAV, VAP BAR	SF	6.03	0.884	0	0
		DEMOLISH HOUSEKEEPING PAD	SF	2.19	0.884	0	0
	3	SUPERSTRUCTURE					
		STEEL FRAMING	SF	4.10	0.936	0	0
		ROOF, OPEN WEB JOIST, STL DECK	SF	2.93	0.936	0	0
	4	EXTERIOR CLOSURE					
		CONCRETE BLOCK WALL, PTD	SF	9.83	0.812	0	0
	5	ROOFING					
		TAR & GRAVEL W/ INSULATION	SF	3.36	0.789	0	0
	6	INTERIOR					
		HOLLOW METAL DOOR, 1-HR	EA	1059	0.918	2	1944
		PARTITION, STL STUD / GYP, 1-HR, PTD	SF	4.13	0.818	102	345
	7	MECHANICAL VENTILATION					
		EXHAUST FAN, ROOF CENTRIFUGAL	EA	1025	0.874	1	896
		INTAKE LOUVER	SF	41	0.874	5.5	197
		DUCT DAMPER, 20x16	EA	77	0.874	1	67
		DUCTWORK	LB	6.10	0.874	100	533
		REVISE DUCTWORK	LB	6.10	0.874	0	0
		RELOCATE LOUVER	SF	16	0.874	0	0
	8	CONTROLS					
		DAMPER ACTUATOR, 120V-1PH	EA	259	0.874	1	226
		THERMOSTAT, 120V-1PH	EA	65	0.874	1	57
		REFRIGERATION SENSOR/ALARM	EA	1200	0.874	1	1049
	9	ELECTRICAL					
		WIRE & CONDUIT, 1/3 HP FAN MOTOR	EA	775	0.787	1	610
		EMERG SHUT-DOWN & VENT SWITCHES	EA	147	0.787	2	231
		LIGHTS & RECEPTACLES	SF	2.60	0.787	0	0
							6155
				CONTINGENCY			1.20
				TOTAL			7386

COMMENTS:

1. REFRIGERANT = 485# OF R-113 / MECH ROOM IN BASEMENT
2. CHILLER IN ROOM WITH GAS-FIRED BOILER
3. VERY EASY TO ISOLATE THE CHILLER

PLANT BLDG NO	ITEM	DESCRIPTION	UNIT	UNIT COST	COST ADJUST (AUSTIN)	QTY	TOTAL COST
7050	1	FOUNDATIONS					
		FOUNDATION & FOOTINGS	SF	7.20	0.884	0	0
		EXCAVATION & BACKFILL	SF	1.59	0.884	0	0
	2	SUBSTRUCTURE					
		6" SLAB ON GRADE, GRAV, VAP BAR	SF	6.03	0.884	0	0
		DEMOLISH HOUSEKEEPING PAD	SF	2.19	0.884	0	0
	3	SUPERSTRUCTURE					
		STEEL FRAMING	SF	4.10	0.936	0	0
		ROOF, OPEN WEB JOIST, STL DECK	SF	2.93	0.936	0	0
	4	EXTERIOR CLOSURE					
		CONCRETE BLOCK WALL, PTD	SF	9.83	0.812	0	0
	5	ROOFING					
		TAR & GRAVEL W/ INSULATION	SF	3.36	0.789	0	0
	6	INTERIOR					
		HOLLOW METAL DOOR, 1-HR	EA	1059	0.918	2	1944
		PARTITION, STL STUD / GYP, 1-HR, PTD	SF	4.13	0.818	434	1466
	7	MECHANICAL VENTILATION					
		EXHAUST FAN, ROOF CENTRIFUGAL	EA	1500	0.874	1	1311
		INTAKE LOUVER	SF	41	0.874	9.3	333
		DUCT DAMPER, 36x16	EA	166	0.874	1	145
		DUCTWORK	LB	6.10	0.874	142	757
		REVISE DUCTWORK	LB	6.10	0.874	0	0
		RELOCATE LOUVER	SF	16	0.874	0	0
	8	CONTROLS					
		DAMPER ACTUATOR, 120V-1PH	EA	259	0.874	1	226
		THERMOSTAT, 120V-1PH	EA	65	0.874	1	57
		REFRIGERATION SENSOR/ALARM	EA	1200	0.874	1	1049
	9	ELECTRICAL					
		WIRE & CONDUIT, 1 HP FAN MOTOR	EA	820	0.787	1	645
		EMERG SHUT-DOWN & VENT SWITCHES	EA	147	0.787	2	231
		LIGHTS & RECEPTACLES	SF	2.60	0.787	0	0
							8164
				CONTINGENCY			1.20
				TOTAL			9797

COMMENTS:

1. REFRIGERANT = 1580# OF R-12 / MECH ROOM @ GROUND LEVEL
2. TWO CHILLERS IN ROOM WITH GAS-FIRED BOILER
3. VERY EASY TO ISOLATE THE CHILLER

APPENDIX I

Table I-5. Calculation of Cost to Upgrade Mechanical Rooms

PLANT BLDG NO	ITEM	DESCRIPTION	UNIT	UNIT COST	COST ADJUST (AUSTIN)	QTY	TOTAL COST
7051	1	FOUNDATIONS					
		FOUNDATION & FOOTINGS	SF	7.20	0.884	0	0
		EXCAVATION & BACKFILL	SF	1.59	0.884	0	0
	2	SUBSTRUCTURE					
		6" SLAB ON GRADE, GRAV, VAP BAR	SF	6.03	0.884	0	0
		DEMOLISH HOUSEKEEPING PAD	SF	2.19	0.884	0	0
	3	SUPERSTRUCTURE					
		STEEL FRAMING	SF	4.10	0.936	0	0
		ROOF, OPEN WEB JOIST, STL DECK	SF	2.93	0.936	0	0
	4	EXTERIOR CLOSURE					
		CONCRETE BLOCK WALL, PTD	SF	9.83	0.812	0	0
	5	ROOFING					
		TAR & GRAVEL W/ INSULATION	SF	3.36	0.789	0	0
	6	INTERIOR					
		HOLLOW METAL DOOR, 1-HR	EA	1059	0.918	2	1944
		PARTITION, STL STUD / GYP, 1-HR, PTD	SF	4.13	0.818	434	1466
	7	MECHANICAL VENTILATION					
		EXHAUST FAN, ROOF CENTRIFUGAL	EA	1500	0.874	1	1311
		INTAKE LOUVER	SF	41	0.874	9.3	333
		DUCT DAMPER, 24x18	EA	93	0.874	1	81
		DUCTWORK	LB	6.10	0.874	120	640
		REVISE DUCTWORK	LB	6.10	0.874	0	0
		RELOCATE LOUVER	SF	18	0.874	0	0
	8	CONTROLS					
		DAMPER ACTUATOR, 120V-1PH	EA	259	0.874	1	226
		THERMOSTAT, 120V-1PH	EA	65	0.874	1	57
		REFRIGERATION SENSOR/ALARM	EA	1200	0.874	1	1049
	9	ELECTRICAL					
		WIRE & CONDUIT, 1/2 HP FAN MOTOR	EA	790	0.787	1	622
		EMERG SHUT-DOWN & VENT SWITCHES	EA	147	0.787	2	231
		LIGHTS & RECEPTACLES	SF	2.60	0.787	0	0
							7960
				CONTINGENCY			1.20
				TOTAL			9552

COMMENTS:

1. REFRIGERANT = 1200# OF R-11 / MECH ROOM @ GROUND LEVEL
2. TWO CHILLERS IN ROOM WITH GAS-FIRED BOILER
3. VERY EASY TO ISOLATE THE CHILLER

PLANT BLDG NO	ITEM	DESCRIPTION	UNIT	UNIT COST	COST ADJUST (AUSTIN)	QTY	TOTAL COST
14020	1	FOUNDATIONS					
		FOUNDATION & FOOTINGS	SF	7.20	0.884	0	0
		EXCAVATION & BACKFILL	SF	1.59	0.884	0	0
	2	SUBSTRUCTURE					
		6" SLAB ON GRADE, GRAV, VAP BAR	SF	6.03	0.884	0	0
		DEMOLISH HOUSEKEEPING PAD	SF	2.19	0.884	0	0
	3	SUPERSTRUCTURE					
		STEEL FRAMING	SF	4.10	0.936	0	0
		ROOF, OPEN WEB JOIST, STL DECK	SF	2.93	0.936	0	0
	4	EXTERIOR CLOSURE					
		CONCRETE BLOCK WALL, PTD	SF	9.83	0.812	0	0
	5	ROOFING					
		TAR & GRAVEL W/ INSULATION	SF	3.36	0.789	0	0
	6	INTERIOR					
		HOLLOW METAL DOOR, 1-HR	EA	1059	0.918	2	1944
		PARTITION, STL STUD / GYP, 1-HR, PTD	SF	4.13	0.818	287	970
	7	MECHANICAL VENTILATION					
		EXHAUST FAN, ROOF CENTRIFUGAL	EA	1025	0.874	1	896
		INTAKE LOUVER	SF	41	0.874	5.5	197
		DUCT DAMPER, 20x16	EA	77	0.874	1	67
		DUCTWORK	LB	6.10	0.874	100	533
		REVISE DUCTWORK	LB	6.10	0.874	0	0
		RELOCATE LOUVER	SF	16	0.874	0	0
	8	CONTROLS					
		DAMPER ACTUATOR, 120V-1PH	EA	259	0.874	1	226
		THERMOSTAT, 120V-1PH	EA	65	0.874	1	57
		REFRIGERATION SENSOR/ALARM	EA	1200	0.874	1	1049
	9	ELECTRICAL					
		WIRE & CONDUIT, 1/3 HP FAN MOTOR	EA	775	0.787	1	610
		EMERG SHUT-DOWN & VENT SWITCHES	EA	147	0.787	2	231
		LIGHTS & RECEPTACLES	SF	2.60	0.787	0	0
							6780
				CONTINGENCY			1.20
				TOTAL			8136

COMMENTS:

1. REFRIGERANT = 415# OF R-113 / MECH ROOM IN BASEMENT
2. CHILLER IN ROOM WITH GAS-FIRED BOILER
3. FAIRLY SIMPLE TO ISOLATE THE CHILLER, VENTILATION REVISION DIFFICULT
4. WATCH OUT FOR TUBE PULL ON CHILLER

APPENDIX I

Table I-5. Calculation of Cost to Upgrade Mechanical Rooms

PLANT BLDG NO	ITEM	DESCRIPTION	UNIT	UNIT COST	COST ADJUST (AUSTIN)	QTY	TOTAL COST
14023	1	FOUNDATIONS					
		FOUNDATION & FOOTINGS	SF	7.20	0.884	0	0
		EXCAVATION & BACKFILL	SF	1.59	0.884	0	0
	2	SUBSTRUCTURE					
		6" SLAB ON GRADE, GRAV, VAP BAR	SF	6.03	0.884	0	0
		DEMOLISH HOUSEKEEPING PAD	SF	2.19	0.884	0	0
	3	SUPERSTRUCTURE					
		STEEL FRAMING	SF	4.10	0.936	0	0
		ROOF, OPEN WEB JOIST, STL DECK	SF	2.93	0.936	0	0
	4	EXTERIOR CLOSURE					
		CONCRETE BLOCK WALL, PTD	SF	9.83	0.812	0	0
	5	ROOFING					
		TAR & GRAVEL W/ INSULATION	SF	3.36	0.789	0	0
	6	INTERIOR					
		HOLLOW METAL DOOR, 1-HR	EA	1059	0.918	2	1944
		PARTITION, STL STUD / GYP, 1-HR, PTD	SF	4.13	0.818	287	970
	7	MECHANICAL VENTILATION					
		EXHAUST FAN, ROOF CENTRIFUGAL	EA	1025	0.874	1	896
		INTAKE LOUVER	SF	41	0.874	5.5	197
		DUCT DAMPER, 20x16	EA	77	0.874	1	67
		DUCTWORK	LB	6.10	0.874	100	533
		REVISE DUCTWORK	LB	6.10	0.874	0	0
		RELOCATE LOUVER	SF	16	0.874	0	0
	8	CONTROLS					
		DAMPER ACTUATOR, 120V-1PH	EA	259	0.874	1	226
		THERMOSTAT, 120V-1PH	EA	65	0.874	1	57
		REFRIGERATION SENSOR/ALARM	EA	1200	0.874	1	1049
	9	ELECTRICAL					
		WIRE & CONDUIT, 1/3 HP FAN MOTOR	EA	775	0.787	1	610
		EMERG SHUT-DOWN & VENT SWITCHES	EA	147	0.787	2	231
		LIGHTS & RECEPTACLES	SF	2.60	0.787	0	0
							6780
				CONTINGENCY			1.20
COMMENTS:				TOTAL			8136

1. REFRIGERANT = 415# OF R-113 / MECH ROOM IN BASEMENT
2. CHILLER IN ROOM WITH GAS-FIRED BOILER
3. FAIRLY SIMPLE TO ISOLATE THE CHILLER, VENTILATION REVISION DIFFICULT
4. WATCH OUT FOR TUBE PULL ON CHILLER

21002	1	FOUNDATIONS					
		FOUNDATION & FOOTINGS	SF	7.20	0.884	352	2240
		EXCAVATION & BACKFILL	SF	1.59	0.884	352	495
	2	SUBSTRUCTURE					
		8" SLAB ON GRADE, GRAV, VAP BAR	SF	6.03	0.884	352	1876
		DEMOLISH HOUSEKEEPING PAD	SF	2.19	0.884	72	139
	3	SUPERSTRUCTURE					
		STEEL FRAMING	SF	4.10	0.936	352	1351
		ROOF, OPEN WEB JOIST, STL DECK	SF	2.93	0.936	352	965
	4	EXTERIOR CLOSURE					
		CONCRETE BLOCK WALL, PTD	SF	9.83	0.812	530	4230
	5	ROOFING					
		TAR & GRAVEL W/ INSULATION	SF	3.36	0.789	352	933
	6	INTERIOR					
		HOLLOW METAL DOOR, 1-HR	EA	1059	0.918	2	1944
		PARTITION, STL STUD / GYP, 1-HR, PTD	SF	4.13	0.818	0	0
	7	MECHANICAL VENTILATION					
		EXHAUST FAN, ROOF CENTRIFUGAL	EA	1500	0.874	1	1311
		INTAKE LOUVER	SF	41	0.874	7.5	269
		DUCT DAMPER, 24x16	EA	93	0.874	1	81
		DUCTWORK	LB	6.10	0.874	110	586
		REVISE DUCTWORK	LB	6.10	0.874	0	0
		RELOCATE LOUVER	SF	16	0.874	25	350
	8	CONTROLS					
		DAMPER ACTUATOR, 120V-1PH	EA	259	0.874	1	226
		THERMOSTAT, 120V-1PH	EA	65	0.874	1	57
		REFRIGERATION SENSOR/ALARM	EA	1200	0.874	1	1049
	9	ELECTRICAL					
		WIRE & CONDUIT, 1/2 HP FAN MOTOR	EA	790	0.787	1	622
		EMERG SHUT-DOWN & VENT SWITCHES	EA	147	0.787	2	231
		LIGHTS & RECEPTACLES	SF	2.60	0.787	352	720
							19675
				CONTINGENCY			1.20
COMMENTS:				TOTAL			23610

1. REFRIGERANT = 680# OF R-12 / MECH ROOM @ GROUND LEVEL
2. CHILLER IN ROOM WITH GAS-FIRED BOILERS AND AIR-HANDLING UNIT
3. VERY DIFFICULT TO ISOLATE THE CHILLER IN SAME LOCATION
4. RECOMMEND EXTENDING NORTH END OF THE MECH ROOM 10', OR WEST END IF TOWER IS REPLACED

APPENDIX I

Table I-5. Calculation of Cost to Upgrade Mechanical Rooms

PLANT BLDG NO	ITEM	DESCRIPTION	UNIT	UNIT COST	COST ADJUST (AUSTIN)	QTY	TOTAL COST
27004	1	FOUNDATIONS					
		FOUNDATION & FOOTINGS	SF	7.20	0.884	0	0
		EXCAVATION & BACKFILL	SF	1.59	0.884	0	0
	2	SUBSTRUCTURE					
		6" SLAB ON GRADE, GRAV, VAP BAR	SF	6.03	0.884	0	0
		DEMOLISH HOUSEKEEPING PAD	SF	2.19	0.884	0	0
	3	SUPERSTRUCTURE					
		STEEL FRAMING	SF	4.10	0.936	0	0
		ROOF, OPEN WEB JOIST, STL DECK	SF	2.93	0.936	0	0
	4	EXTERIOR CLOSURE					
		CONCRETE BLOCK WALL, PTD	SF	9.83	0.812	0	0
	5	ROOFING					
		TAR & GRAVEL W/ INSULATION	SF	3.36	0.789	0	0
	6	INTERIOR					
		HOLLOW METAL DOOR, 1-HR	EA	1059	0.918	2	1944
		PARTITION, STL STUD / GYP, 1-HR, PTD	SF	4.13	0.818	288	973
	7	MECHANICAL VENTILATION					
		EXHAUST FAN, ROOF CENTRIFUGAL	EA	1500	0.874	1	1311
		INTAKE LOUVER	SF	41	0.874	9.3	333
		DUCT DAMPER, 24x18	EA	93	0.874	1	81
		DUCTWORK	LB	6.10	0.874	120	640
		REVISE DUCTWORK	LB	6.10	0.874	0	0
		RELOCATE LOUVER	SF	16	0.874	0	0
	8	CONTROLS					
		DAMPER ACTUATOR, 120V-1PH	EA	259	0.874	1	226
		THERMOSTAT, 120V-1PH	EA	65	0.874	1	57
		REFRIGERATION SENSOR/ALARM	EA	1200	0.874	1	1049
	9	ELECTRICAL					
		WIRE & CONDUIT, 1/2 HP FAN MOTOR	EA	790	0.787	1	622
		EMERG SHUT-DOWN & VENT SWITCHES	EA	147	0.787	2	231
		LIGHTS & RECEPTACLES	SF	2.60	0.787	0	0
							7467
				CONTINGENCY			1.20
				TOTAL			8960

COMMENTS:

1. REFRIGERANT - 1300# OF R-12 / MECH ROOM @ GROUND LEVEL
2. CHILLER IN ROOM WITH GAS-FIRED BOILERS
3. TIGHT, BUT SHOULD BE ABLE TO SQUEEZE IN WALL TO ISOLATE THE CHILLER

PLANT BLDG NO	ITEM	DESCRIPTION	UNIT	UNIT COST	COST ADJUST (AUSTIN)	QTY	TOTAL COST
28000	1	FOUNDATIONS					
		FOUNDATION & FOOTINGS	SF	7.20	0.884	0	0
		EXCAVATION & BACKFILL	SF	1.59	0.884	0	0
	2	SUBSTRUCTURE					
		6" SLAB ON GRADE, GRAV, VAP BAR	SF	6.03	0.884	0	0
		DEMOLISH HOUSEKEEPING PAD	SF	2.19	0.884	0	0
	3	SUPERSTRUCTURE					
		STEEL FRAMING	SF	4.10	0.936	0	0
		ROOF, OPEN WEB JOIST, STL DECK	SF	2.93	0.936	0	0
	4	EXTERIOR CLOSURE					
		CONCRETE BLOCK WALL, PTD	SF	9.83	0.812	0	0
	5	ROOFING					
		TAR & GRAVEL W/ INSULATION	SF	3.36	0.789	0	0
	6	INTERIOR					
		HOLLOW METAL DOOR, 1-HR	EA	1059	0.918	2	1944
		PARTITION, STL STUD / GYP, 1-HR, PTD	SF	4.13	0.818	240	811
	7	MECHANICAL VENTILATION					
		EXHAUST FAN, ROOF CENTRIFUGAL	EA	1500	0.874	1	1311
		INTAKE LOUVER	SF	41	0.874	7.5	269
		DUCT DAMPER, 24x16	EA	93	0.874	1	81
		DUCTWORK	LB	6.10	0.874	110	586
		REVISE DUCTWORK	LB	6.10	0.874	270	1439
		RELOCATE LOUVER	SF	16	0.874	16	224
	8	CONTROLS					
		DAMPER ACTUATOR, 120V-1PH	EA	259	0.874	1	226
		THERMOSTAT, 120V-1PH	EA	65	0.874	1	57
		REFRIGERATION SENSOR/ALARM	EA	1200	0.874	1	1049
	9	ELECTRICAL					
		WIRE & CONDUIT, 1/2 HP FAN MOTOR	EA	790	0.787	1	622
		EMERG SHUT-DOWN & VENT SWITCHES	EA	147	0.787	2	231
		LIGHTS & RECEPTACLES	SF	2.60	0.787	0	0
							8850
				CONTINGENCY			1.20
				TOTAL			10620

COMMENTS:

1. REFRIGERANT - 780# OF R-12 / MECH ROOM @ GROUND LEVEL
2. TWO CHILLERS IN ROOM WITH GAS-FIRED BOILER
3. VERY EASY TO ISOLATE THE CHILLER
4. WATCH TUBE-PULL CLEARANCES AND WALL/FLUE HEADER CONFLICTS

APPENDIX I

Table I-5. Calculation of Cost to Upgrade Mechanical Rooms

PLANT BLDG NO	ITEM	DESCRIPTION	UNIT	UNIT COST	COST ADJUST (AUSTIN)	QTY	TOTAL COST
29005	1	FOUNDATIONS					
		FOUNDATION & FOOTINGS	SF	7.20	0.884	0	0
		EXCAVATION & BACKFILL	SF	1.59	0.884	0	0
	2	SUBSTRUCTURE					
		6" SLAB ON GRADE, GRAV, VAP BAR	SF	6.03	0.884	0	0
		DEMOLISH HOUSEKEEPING PAD	SF	2.19	0.884	0	0
	3	SUPERSTRUCTURE					
		STEEL FRAMING	SF	4.10	0.936	0	0
		ROOF, OPEN WEB JOIST, STL DECK	SF	2.93	0.936	0	0
	4	EXTERIOR CLOSURE					
		CONCRETE BLOCK WALL, PTD	SF	9.83	0.812	0	0
	5	ROOFING					
		TAR & GRAVEL W/ INSULATION	SF	3.36	0.789	0	0
	6	INTERIOR					
		HOLLOW METAL DOOR, 1-HR	EA	1059	0.918	2	1944
		PARTITION, STL STUD / GYP, 1-HR, PTD	SF	4.13	0.818	264	892
	7	MECHANICAL VENTILATION					
		EXHAUST FAN, ROOF CENTRIFUGAL	EA	1500	0.874	1	1311
		INTAKE LOUVER	SF	41	0.874	9.3	333
		DUCT DAMPER, 36x16	EA	166	0.874	1	145
		DUCTWORK	LB	6.10	0.874	142	757
		REVISE DUCTWORK	LB	6.10	0.874	0	0
		RELOCATE LOUVER	SF	16	0.874	0	0
	8	CONTROLS					
		DAMPER ACTUATOR, 120V-1PH	EA	259	0.874	1	226
		THERMOSTAT, 120V-1PH	EA	65	0.874	1	57
		REFRIGERATION SENSOR/ALARM	EA	1200	0.874	1	1049
	9	ELECTRICAL					
		WIRE & CONDUIT, 1 HP FAN MOTOR	EA	820	0.787	1	645
		EMERG SHUT-DOWN & VENT SWITCHES	EA	147	0.787	2	231
		LIGHTS & RECEPTACLES	SF	2.60	0.787	0	0
							7590
				CONTINGENCY			1.20
				TOTAL			9108

COMMENTS:

1. REFRIGERANT = 1760# OF R-11 / MECH ROOM @ GROUND LEVEL
2. TWO CHILLERS IN ROOM WITH GAS-FIRED BOILER
3. VERY EASY TO ISOLATE THE CHILLER, BUT LOTS OF LARGE PIPE PENETRATIONS IN NEW WALL

PLANT BLDG NO	ITEM	DESCRIPTION	UNIT	UNIT COST	COST ADJUST (AUSTIN)	QTY	TOTAL COST
31008	1	FOUNDATIONS					
		FOUNDATION & FOOTINGS	SF	7.20	0.884	352	2240
		EXCAVATION & BACKFILL	SF	1.59	0.884	352	495
	2	SUBSTRUCTURE					
		6" SLAB ON GRADE, GRAV, VAP BAR	SF	6.03	0.884	352	1876
		DEMOLISH HOUSEKEEPING PAD	SF	2.19	0.884	72	139
	3	SUPERSTRUCTURE					
		STEEL FRAMING	SF	4.10	0.936	352	1351
		ROOF, OPEN WEB JOIST, STL DECK	SF	2.93	0.936	352	965
	4	EXTERIOR CLOSURE					
		CONCRETE BLOCK WALL, PTD	SF	9.83	0.812	530	4230
	5	ROOFING					
		TAR & GRAVEL W/ INSULATION	SF	3.36	0.789	352	933
	6	INTERIOR					
		HOLLOW METAL DOOR, 1-HR	EA	1059	0.918	2	1944
		PARTITION, STL STUD / GYP, 1-HR, PTD	SF	4.13	0.818	0	0
	7	MECHANICAL VENTILATION					
		EXHAUST FAN, ROOF CENTRIFUGAL	EA	1500	0.874	1	1311
		INTAKE LOUVER	SF	41	0.874	9.3	333
		DUCT DAMPER, 24x18	EA	93	0.874	1	81
		DUCTWORK	LB	6.10	0.874	120	640
		REVISE DUCTWORK	LB	6.10	0.874	0	0
		RELOCATE LOUVER	SF	16	0.874	25	350
	8	CONTROLS					
		DAMPER ACTUATOR, 120V-1PH	EA	259	0.874	1	228
		THERMOSTAT, 120V-1PH	EA	65	0.874	1	57
		REFRIGERATION SENSOR/ALARM	EA	1200	0.874	1	1049
	9	ELECTRICAL					
		WIRE & CONDUIT, 1/2 HP FAN MOTOR	EA	790	0.787	1	622
		EMERG SHUT-DOWN & VENT SWITCHES	EA	147	0.787	2	231
		LIGHTS & RECEPTACLES	SF	2.60	0.787	352	720
							19793
				CONTINGENCY			1.20
				TOTAL			23752

COMMENTS:

1. REFRIGERANT = 1350# OF R-22 / MECH ROOM @ GROUND LEVEL
2. CHILLER IN ROOM WITH GAS-FIRED BOILERS
3. VERY DIFFICULT TO ISOLATE THE CHILLER
4. RECOMMEND EXTENDING END OF THE MECH ROOM 8'

APPENDIX I

Table I-5. Calculation of Cost to Upgrade Mechanical Rooms

PLANT BLDG NO	ITEM	DESCRIPTION	UNIT	UNIT COST	COST ADJUST (AUSTIN)	QTY	TOTAL COST
34008	1	FOUNDATIONS					
		FOUNDATION & FOOTINGS	SF	7.20	0.884	352	2240
		EXCAVATION & BACKFILL	SF	1.59	0.884	352	495
	2	SUBSTRUCTURE					
		6" SLAB ON GRADE, GRAV, VAP BAR	SF	6.03	0.884	352	1876
		DEMOLISH HOUSEKEEPING PAD	SF	2.19	0.884	72	139
	3	SUPERSTRUCTURE					
		STEEL FRAMING	SF	4.10	0.936	352	1351
		ROOF, OPEN WEB JOIST, STL DECK	SF	2.93	0.936	352	965
	4	EXTERIOR CLOSURE					
		CONCRETE BLOCK WALL, PTD	SF	9.83	0.812	530	4230
	5	ROOFING					
		TAR & GRAVEL W/ INSULATION	SF	3.36	0.789	352	933
	6	INTERIOR					
		HOLLOW METAL DOOR, 1-HR	EA	1059	0.918	2	1944
		PARTITION, STL STUD / GYP, 1-HR, PTD	SF	4.13	0.818	0	0
	7	MECHANICAL VENTILATION					
		EXHAUST FAN, ROOF CENTRIFUGAL	EA	1500	0.874	1	1311
		INTAKE LOUVER	SF	41	0.874	9.3	333
		DUCT DAMPER, 24x18	EA	93	0.874	1	81
		DUCTWORK	LB	6.10	0.874	120	640
		REVISE DUCTWORK	LB	6.10	0.874	0	0
		RELOCATE LOUVER	SF	16	0.874	25	350
	8	CONTROLS					
		DAMPER ACTUATOR, 120V-1PH	EA	259	0.874	1	226
		THERMOSTAT, 120V-1PH	EA	65	0.874	1	57
		REFRIGERATION SENSOR/ALARM	EA	1200	0.874	1	1049
	9	ELECTRICAL					
		WIRE & CONDUIT, 1/2 HP FAN MOTOR	EA	790	0.787	1	622
		EMERG SHUT-DOWN & VENT SWITCHES	EA	147	0.787	2	231
		LIGHTS & RECEPTACLES	SF	2.60	0.787	352	720
							19793
				CONTINGENCY			1.20
				TOTAL			23752

COMMENTS:

1. REFRIGERANT - 1350# OF R-22 / MECH ROOM @ GROUND LEVEL
2. CHILLER IN ROOM WITH GAS-FIRED BOILERS
3. VERY DIFFICULT TO ISOLATE THE CHILLER
4. RECOMMEND EXTENDING END OF THE MECH ROOM 8'

PLANT BLDG NO	ITEM	DESCRIPTION	UNIT	UNIT COST	COST ADJUST (AUSTIN)	QTY	TOTAL COST
36000	1	FOUNDATIONS					
		FOUNDATION & FOOTINGS	SF	7.20	0.884	0	0
		EXCAVATION & BACKFILL	SF	1.59	0.884	0	0
	2	SUBSTRUCTURE					
		6" SLAB ON GRADE, GRAV, VAP BAR	SF	6.03	0.884	84	448
		DEMOLISH HOUSEKEEPING PAD	SF	2.19	0.884	84	163
	3	SUPERSTRUCTURE					
		STEEL FRAMING	SF	4.10	0.936	0	0
		ROOF, OPEN WEB JOIST, STL DECK	SF	2.93	0.936	0	0
	4	EXTERIOR CLOSURE					
		CONCRETE BLOCK WALL, PTD	SF	9.83	0.812	0	0
	5	ROOFING					
		TAR & GRAVEL W/ INSULATION	SF	3.36	0.789	0	0
	6	INTERIOR					
		HOLLOW METAL DOOR, 1-HR	EA	1059	0.918	4	3889
		PARTITION, STL STUD / GYP, 1-HR, PTD	SF	4.13	0.818	2865	9679
	7	MECHANICAL VENTILATION					
		EXHAUST FAN, ROOF CENTRIFUGAL	EA	1500	0.874	1	1311
		INTAKE LOUVER	SF	41	0.874	7.5	269
		DUCT DAMPER, 24x18	EA	93	0.874	1	81
		EXHAUST FAN, ROOF CENTRIFUGAL	EA	1500	0.874	1	1311
		INTAKE LOUVER	SF	41	0.874	9.3	333
		DUCT DAMPER, 36x18	EA	166	0.874	1	145
		DUCTWORK	LB	6.10	0.874	252	1344
	8	CONTROLS					
		DAMPER ACTUATOR, 120V-1PH	EA	259	0.874	2	453
		THERMOSTAT, 120V-1PH	EA	65	0.874	2	114
		REFRIGERATION SENSOR/ALARM	EA	1200	0.874	2	2098
	9	ELECTRICAL					
		WIRE & CONDUIT, 1/2 HP FAN MOTOR	EA	790	0.787	1	622
		EMERG SHUT-DOWN & VENT SWITCHES	EA	147	0.787	4	463
		WIRE & CONDUIT, 1 HP FAN MOTOR	EA	820	0.787	1	645
		LIGHTS & RECEPTACLES	SF	2.60	0.787	0	0
							23368
				CONTINGENCY			1.20
				TOTAL			28042

COMMENTS:

1. REFRIGERANT - 880# & 1640# OF R-11 IN DIFF RMS / MECH RMS ABOVE GRADE
2. CHILLERS IN ROOMS WITH GAS-FIRED BOILERS AND EMERGENCY GENERATORS
3. CHILLER ISOLATION SIMPLE IN ROOM FOR TWO, BUT DOORS WILL HAVE TO DOUBLE AS TUBE-PULL ACCESS
4. CHILLER ISOLATION MORE DIFFICULT FOR LONE UNIT. MUST MOVE CHILLER A FEW FEET.

APPENDIX I

Table I-5. Calculation of Cost to Upgrade Mechanical Rooms

PLANT BLDG NO	ITEM	DESCRIPTION	UNIT	UNIT COST	COST ADJUST (AUSTIN)	QTY	TOTAL COST
36006	1	FOUNDATIONS					
		FOUNDATION & FOOTINGS	SF	7.20	0.884	0	0
		EXCAVATION & BACKFILL	SF	1.59	0.884	0	0
	2	SUBSTRUCTURE					
		6" SLAB ON GRADE, GRAV, VAP BAR	SF	6.03	0.884	48	256
		DEMOLISH HOUSEKEEPING PAD	SF	2.19	0.884	48	93
	3	SUPERSTRUCTURE					
		STEEL FRAMING	SF	4.10	0.936	0	0
		ROOF, OPEN WEB JOIST, STL DECK	SF	2.93	0.936	0	0
	4	EXTERIOR CLOSURE					
		CONCRETE BLOCK WALL, PTD	SF	9.83	0.812	0	0
	5	ROOFING					
		TAR & GRAVEL W/ INSULATION	SF	3.36	0.789	0	0
	6	INTERIOR					
		HOLLOW METAL DOOR, 1-HR	EA	1059	0.918	2	1944
		PARTITION, STL STUD / GYP, 1-HR, PTD	SF	4.13	0.818	520	1757
	7	MECHANICAL VENTILATION					
		EXHAUST FAN, ROOF CENTRIFUGAL	EA	1500	0.874	1	1311
		INTAKE LOUVER	SF	41	0.874	7.5	269
		DUCT DAMPER, 24x16	EA	93	0.874	1	81
		DUCTWORK	LB	6.10	0.874	110	586
		REVISE DUCTWORK	LB	6.10	0.874	120	640
		RELOCATE LOUVER	SF	16	0.874	16	224
	8	CONTROLS					
		DAMPER ACTUATOR, 120V-1PH	EA	259	0.874	1	226
		THERMOSTAT, 120V-1PH	EA	65	0.874	1	57
		REFRIGERATION SENSOR/ALARM	EA	1200	0.874	1	1049
	9	ELECTRICAL					
		WIRE & CONDUIT, 1/2 HP FAN MOTOR	EA	790	0.787	1	622
		EMERG SHUT-DOWN & VENT SWITCHES	EA	147	0.787	2	231
		LIGHTS & RECEPTACLES	SF	2.60	0.787	0	0
							9346
				CONTINGENCY			1.20
				TOTAL			11215

COMMENTS:

1. REFRIGERANT = 650# OF R-11 / MECH ROOM @ GROUND LEVEL
2. CHILLER IN ROOM WITH GAS WATER HEATERS AND AIR-HANDLING UNIT
3. CHILLER & PUMP RELOCATION REQUIRED TO GAIN SPACE FOR ISOLATION

PLANT BLDG NO	ITEM	DESCRIPTION	UNIT	UNIT COST	COST ADJUST (AUSTIN)	QTY	TOTAL COST
36014	1	FOUNDATIONS					
		FOUNDATION & FOOTINGS	SF	7.20	0.884	0	0
		EXCAVATION & BACKFILL	SF	1.59	0.884	0	0
	2	SUBSTRUCTURE					
		6" SLAB ON GRADE, GRAV, VAP BAR	SF	6.03	0.884	0	0
		DEMOLISH HOUSEKEEPING PAD	SF	2.19	0.884	0	0
	3	SUPERSTRUCTURE					
		STEEL FRAMING	SF	4.10	0.936	0	0
		ROOF, OPEN WEB JOIST, STL DECK	SF	2.93	0.936	0	0
	4	EXTERIOR CLOSURE					
		CONCRETE BLOCK WALL, PTD	SF	9.83	0.812	0	0
	5	ROOFING					
		TAR & GRAVEL W/ INSULATION	SF	3.36	0.789	0	0
	6	INTERIOR					
		HOLLOW METAL DOOR, 1-HR	EA	1059	0.918	1	972
		PARTITION, STL STUD / GYP, 1-HR, PTD	SF	4.13	0.818	120	405
	7	MECHANICAL VENTILATION					
		EXHAUST FAN, ROOF CENTRIFUGAL	EA	1025	0.874	1	896
		INTAKE LOUVER	SF	41	0.874	5.5	197
		DUCT DAMPER, 20x16	EA	77	0.874	1	67
		DUCTWORK	LB	6.10	0.874	100	533
		REVISE DUCTWORK	LB	6.10	0.874	0	0
		RELOCATE LOUVER	SF	16	0.874	0	0
	8	CONTROLS					
		DAMPER ACTUATOR, 120V-1PH	EA	259	0.874	1	226
		THERMOSTAT, 120V-1PH	EA	65	0.874	1	57
		REFRIGERATION SENSOR/ALARM	EA	1200	0.874	1	1049
	9	ELECTRICAL					
		WIRE & CONDUIT, 1/3 HP FAN MOTOR	EA	775	0.787	1	610
		EMERG SHUT-DOWN & VENT SWITCHES	EA	147	0.787	2	231
		LIGHTS & RECEPTACLES	SF	2.60	0.787	0	0
							5243
				CONTINGENCY			1.20
				TOTAL			6292

COMMENTS:

1. REFRIGERANT = 175# OF R-22 / MECH ROOM IN BASEMENT
2. CHILLER IN ROOM WITH GAS-FIRED WATER HEATER
3. RELOCATE CHILLER AND WATCH OUT FOR TUBE PULL
4. VENTILATION REVISION DIFFICULT

APPENDIX I

Table I-5. Calculation of Cost to Upgrade Mechanical Rooms

PLANT BLDG NO	ITEM	DESCRIPTION	UNIT	UNIT COST	COST ADJUST (AUSTIN)	QTY	TOTAL COST
39015	1	FOUNDATIONS					
		FOUNDATION & FOOTINGS	SF	7.20	0.884	0	0
		EXCAVATION & BACKFILL	SF	1.59	0.884	0	0
	2	SUBSTRUCTURE					
		6" SLAB ON GRADE, GRAV, VAP BAR	SF	8.03	0.884	120	840
		DEMOLISH HOUSEKEEPING PAD	SF	2.19	0.884	120	232
	3	SUPERSTRUCTURE					
		STEEL FRAMING	SF	4.10	0.936	0	0
		ROOF, OPEN WEB JOIST, STL DECK	SF	2.93	0.936	0	0
	4	EXTERIOR CLOSURE					
		CONCRETE BLOCK WALL, PTD	SF	9.83	0.812	0	0
	5	ROOFING					
		TAR & GRAVEL W/ INSULATION	SF	3.36	0.789	0	0
	6	INTERIOR					
		HOLLOW METAL DOOR, 1-HR	EA	1059	0.918	2	1944
		PARTITION, STL STUD / GYP, 1-HR, PTD	SF	4.13	0.818	264	892
	7	MECHANICAL VENTILATION					
		EXHAUST FAN, ROOF CENTRIFUGAL	EA	1500	0.874	1	1311
		INTAKE LOUVER	SF	41	0.874	9.3	333
		DUCT DAMPER, 36x16	EA	166	0.874	1	145
		DUCTWORK	LB	6.10	0.874	142	757
		REVISE DUCTWORK	LB	6.10	0.874	0	0
		RELOCATE LOUVER	SF	16	0.874	0	0
	8	CONTROLS					
		DAMPER ACTUATOR, 120V-1PH	EA	259	0.874	1	226
		THERMOSTAT, 120V-1PH	EA	65	0.874	1	57
		REFRIGERATION SENSOR/ALARM	EA	1200	0.874	1	1049
	9	ELECTRICAL					
		WIRE & CONDUIT, 1 HP FAN MOTOR	EA	820	0.787	1	645
		EMERG SHUT-DOWN & VENT SWITCHES	EA	147	0.787	2	231
		LIGHTS & RECEPTACLES	SF	2.60	0.787	0	0
							8462
				CONTINGENCY			1.20
COMMENTS:				TOTAL			10154

1. REFRIGERANT = 2500# OF R-11 / MECH ROOM @ GROUND LEVEL
2. TWO CHILLERS IN ROOM WITH GAS-FIRED BOILER
3. RELOCATE ONE OR BOTH CHILLERS TO MAKE ROOM FOR WALL

PLANT BLDG NO	ITEM	DESCRIPTION	UNIT	UNIT COST	COST ADJUST (AUSTIN)	QTY	TOTAL COST
39043	1	FOUNDATIONS					
		FOUNDATION & FOOTINGS	SF	7.20	0.884	0	0
		EXCAVATION & BACKFILL	SF	1.59	0.884	0	0
	2	SUBSTRUCTURE					
		6" SLAB ON GRADE, GRAV, VAP BAR	SF	8.03	0.884	0	0
		DEMOLISH HOUSEKEEPING PAD	SF	2.19	0.884	0	0
	3	SUPERSTRUCTURE					
		STEEL FRAMING	SF	4.10	0.936	0	0
		ROOF, OPEN WEB JOIST, STL DECK	SF	2.93	0.936	0	0
	4	EXTERIOR CLOSURE					
		CONCRETE BLOCK WALL, PTD	SF	9.83	0.812	0	0
	5	ROOFING					
		TAR & GRAVEL W/ INSULATION	SF	3.36	0.789	0	0
	6	INTERIOR					
		HOLLOW METAL DOOR, 1-HR	EA	1059	0.918	0	0
		PARTITION, STL STUD / GYP, 1-HR, PTD	SF	4.13	0.818	384	1297
	7	MECHANICAL VENTILATION					
		EXHAUST FAN, ROOF CENTRIFUGAL	EA	1500	0.874	1	1311
		INTAKE LOUVER	SF	41	0.874	9.3	333
		DUCT DAMPER, 36x16	EA	166	0.874	1	145
		DUCTWORK	LB	6.10	0.874	142	757
		REVISE DUCTWORK	LB	6.10	0.874	0	0
		RELOCATE LOUVER	SF	16	0.874	0	0
	8	CONTROLS					
		DAMPER ACTUATOR, 120V-1PH	EA	259	0.874	1	226
		THERMOSTAT, 120V-1PH	EA	65	0.874	1	57
		REFRIGERATION SENSOR/ALARM	EA	1200	0.874	1	1049
	9	ELECTRICAL					
		WIRE & CONDUIT, 1 HP FAN MOTOR	EA	820	0.787	1	645
		EMERG SHUT-DOWN & VENT SWITCHES	EA	147	0.787	2	231
		LIGHTS & RECEPTACLES	SF	2.60	0.787	0	0
							6051
				CONTINGENCY			1.20
COMMENTS:				TOTAL			7261

1. REFRIGERANT = 2350# OF R-11 / MECH ROOM @ GROUND LEVEL
2. TWO CHILLERS IN ROOM WITH GAS-FIRED BOILER
3. VERY EASY TO ISOLATE THE CHILLER

APPENDIX I

Table I-5. Calculation of Cost to Upgrade Mechanical Rooms

PLANT BLDG NO	ITEM	DESCRIPTION	UNIT	UNIT COST	COST ADJUST (AUSTIN)	QTY	TOTAL COST
41003	1	FOUNDATIONS					
		FOUNDATION & FOOTINGS	SF	7.20	0.884	0	0
		EXCAVATION & BACKFILL	SF	1.59	0.884	0	0
	2	SUBSTRUCTURE					
		6" SLAB ON GRADE, GRAV, VAP BAR	SF	6.03	0.884	0	0
		DEMOLISH HOUSEKEEPING PAD	SF	2.19	0.884	0	0
	3	SUPERSTRUCTURE					
		STEEL FRAMING	SF	4.10	0.936	0	0
		ROOF, OPEN WEB JOIST, STL DECK	SF	2.93	0.936	0	0
	4	EXTERIOR CLOSURE					
		CONCRETE BLOCK WALL, PTD	SF	9.83	0.812	0	0
	5	ROOFING					
		TAR & GRAVEL W/ INSULATION	SF	3.36	0.789	0	0
	6	INTERIOR					
		HOLLOW METAL DOOR, 1-HR	EA	1059	0.918	2	1944
		PARTITION, STL STUD / GYP, 1-HR, PTD	SF	4.13	0.818	360	1216
	7	MECHANICAL VENTILATION					
		EXHAUST FAN, ROOF CENTRIFUGAL	EA	1500	0.874	1	1311
		INTAKE LOUVER	SF	41	0.874	7.5	269
		DUCT DAMPER, 24x16	EA	93	0.874	1	81
		DUCTWORK	LB	6.10	0.874	110	586
		REVISE DUCTWORK	LB	6.10	0.874	0	0
		RELOCATE LOUVER	SF	16	0.874	0	0
	8	CONTROLS					
		DAMPER ACTUATOR, 120V-1PH	EA	259	0.874	1	226
		THERMOSTAT, 120V-1PH	EA	65	0.874	1	57
		REFRIGERATION SENSOR/ALARM	EA	1200	0.874	1	1049
	9	ELECTRICAL					
		WIRE & CONDUIT, 1/2 HP FAN MOTOR	EA	790	0.787	1	622
		EMERG SHUT-DOWN & VENT SWITCHES	EA	147	0.787	2	231
		LIGHTS & RECEPTACLES	SF	2.60	0.787	0	0
							7592
				CONTINGENCY			1.20
				TOTAL			9110

COMMENTS:

1. REFRIGERANT = 670# OF R-12 / MECH ROOM IN BASEMENT
2. CHILLER IN ROOM WITH GAS-FIRED BOILER
3. VERY DIFFICULT TO ISOLATE THE CHILLER AND MAINTAIN CLEARANCES
4. RECOMMEND EXTENDING EAST END OF THE MECH ROOM 10', OR NORTH END IF TOWER IS REPLACED

PLANT BLDG NO	ITEM	DESCRIPTION	UNIT	UNIT COST	COST ADJUST (AUSTIN)	QTY	TOTAL COST
42000	1	FOUNDATIONS					
		FOUNDATION & FOOTINGS	SF	7.20	0.884	0	0
		EXCAVATION & BACKFILL	SF	1.59	0.884	0	0
	2	SUBSTRUCTURE					
		6" SLAB ON GRADE, GRAV, VAP BAR	SF	6.03	0.884	0	0
		DEMOLISH HOUSEKEEPING PAD	SF	2.19	0.884	0	0
	3	SUPERSTRUCTURE					
		STEEL FRAMING	SF	4.10	0.936	0	0
		ROOF, OPEN WEB JOIST, STL DECK	SF	2.93	0.936	0	0
	4	EXTERIOR CLOSURE					
		CONCRETE BLOCK WALL, PTD	SF	9.83	0.812	0	0
	5	ROOFING					
		TAR & GRAVEL W/ INSULATION	SF	3.36	0.789	0	0
	6	INTERIOR					
		HOLLOW METAL DOOR, 1-HR	EA	1059	0.918	1	972
		PARTITION, STL STUD / GYP, 1-HR, PTD	SF	4.13	0.818	230	777
	7	MECHANICAL VENTILATION					
		EXHAUST FAN, ROOF CENTRIFUGAL	EA	1500	0.874	1	1311
		INTAKE LOUVER	SF	41	0.874	7.5	269
		DUCT DAMPER, 24x16	EA	93	0.874	1	81
		DUCTWORK	LB	6.10	0.874	110	586
		REVISE DUCTWORK	LB	6.10	0.874	0	0
		RELOCATE LOUVER	SF	16	0.874	0	0
	8	CONTROLS					
		DAMPER ACTUATOR, 120V-1PH	EA	259	0.874	1	226
		THERMOSTAT, 120V-1PH	EA	65	0.874	1	57
		REFRIGERATION SENSOR/ALARM	EA	1200	0.874	1	1049
	9	ELECTRICAL					
		WIRE & CONDUIT, 1/2 HP FAN MOTOR	EA	790	0.787	1	622
		EMERG SHUT-DOWN & VENT SWITCHES	EA	147	0.787	2	231
		LIGHTS & RECEPTACLES	SF	2.60	0.787	0	0
							6181
				CONTINGENCY			1.20
				TOTAL			7417

COMMENTS:

1. REFRIGERANT = 650# OF R-11 / MECH ROOM @ GROUND LEVEL
2. CHILLER IN ROOM WITH GAS-FIRED BOILER AND WATER HEATERS
3. DIFFICULT TO ISOLATE THE CHILLER, WATCH CLEARANCES
4. VENTILATION REVISION DIFFICULT

APPENDIX I

Table I-5. Calculation of Cost to Upgrade Mechanical Rooms

PLANT BLDG NO	ITEM	DESCRIPTION	UNIT	UNIT COST	COST ADJUST (AUSTIN)	QTY	TOTAL COST
50001	1	FOUNDATIONS					
		FOUNDATION & FOOTINGS	SF	7.20	0.884	0	0
		EXCAVATION & BACKFILL	SF	1.59	0.884	0	0
	2	SUBSTRUCTURE					
		6" SLAB ON GRADE, GRAV, VAP BAR	SF	6.03	0.884	24	128
		DEMOLISH HOUSEKEEPING PAD	SF	2.19	0.884	24	46
	3	SUPERSTRUCTURE					
		STEEL FRAMING	SF	4.10	0.936	0	0
		ROOF, OPEN WEB JOIST, STL DECK	SF	2.93	0.936	0	0
	4	EXTERIOR CLOSURE					
		CONCRETE BLOCK WALL, PTD	SF	9.83	0.812	0	0
	5	ROOFING					
		TAR & GRAVEL W/ INSULATION	SF	3.36	0.789	0	0
	6	INTERIOR					
		HOLLOW METAL DOOR, 1-HR	EA	1059	0.918	1	972
		PARTITION, STL STUD / GYP, 1-HR, PTD	SF	4.13	0.818	372	1257
	7	MECHANICAL VENTILATION					
		EXHAUST FAN, ROOF CENTRIFUGAL	EA	1025	0.874	1	896
		INTAKE LOUVER	SF	41	0.874	5.5	197
		DUCT DAMPER, 20x16	EA	77	0.874	1	67
		DUCTWORK	LB	6.10	0.874	400	2133
		REVISE DUCTWORK	LB	6.10	0.874	0	0
		RELOCATE LOUVER	SF	16	0.874	0	0
	8	CONTROLS					
		DAMPER ACTUATOR, 120V-1PH	EA	259	0.874	1	226
		THERMOSTAT, 120V-1PH	EA	65	0.874	1	57
		REFRIGERATION SENSOR/ALARM	EA	1200	0.874	1	1049
	9	ELECTRICAL					
		WIRE & CONDUIT, 1/3 HP FAN MOTOR	EA	775	0.787	1	610
		EMERG SHUT-DOWN & VENT SWITCHES	EA	147	0.787	2	231
		LIGHTS & RECEPTACLES	SF	2.60	0.787	0	0
							7869
				CONTINGENCY			1.20
				TOTAL			9443

COMMENTS:

1. REFRIGERANT - 200# OF R-22 / MECH ROOM ABOVE GRADE
2. CHILLER IN ROOM WITH GAS-FIRED BOILER
3. FAIRLY SIMPLE TO ISOLATE THE CHILLER
4. MOVE CHILLER TO GET CLEARANCES

PLANT BLDG NO	ITEM	DESCRIPTION	UNIT	UNIT COST	COST ADJUST (AUSTIN)	QTY	TOTAL COST
50004	1	FOUNDATIONS					
		FOUNDATION & FOOTINGS	SF	7.20	0.884	0	0
		EXCAVATION & BACKFILL	SF	1.59	0.884	0	0
	2	SUBSTRUCTURE					
		6" SLAB ON GRADE, GRAV, VAP BAR	SF	6.03	0.884	40	213
		DEMOLISH HOUSEKEEPING PAD	SF	2.19	0.884	40	77
	3	SUPERSTRUCTURE					
		STEEL FRAMING	SF	4.10	0.936	0	0
		ROOF, OPEN WEB JOIST, STL DECK	SF	2.93	0.936	0	0
	4	EXTERIOR CLOSURE					
		CONCRETE BLOCK WALL, PTD	SF	9.83	0.812	0	0
	5	ROOFING					
		TAR & GRAVEL W/ INSULATION	SF	3.36	0.789	0	0
	6	INTERIOR					
		HOLLOW METAL DOOR, 1-HR	EA	1059	0.918	2	1944
		PARTITION, STL STUD / GYP, 1-HR, PTD	SF	4.13	0.818	896	3027
	7	MECHANICAL VENTILATION					
		EXHAUST FAN, ROOF CENTRIFUGAL	EA	1500	0.874	1	1311
		INTAKE LOUVER	SF	41	0.874	9.3	333
		DUCT DAMPER, 24x18	EA	93	0.874	1	81
		DUCTWORK	LB	6.10	0.874	120	640
		REVISE DUCTWORK	LB	6.10	0.874	0	0
		RELOCATE LOUVER	SF	16	0.874	0	0
	8	CONTROLS					
		DAMPER ACTUATOR, 120V-1PH	EA	259	0.874	1	226
		THERMOSTAT, 120V-1PH	EA	65	0.874	1	57
		REFRIGERATION SENSOR/ALARM	EA	1200	0.874	1	1049
	9	ELECTRICAL					
		WIRE & CONDUIT, 1/2 HP FAN MOTOR	EA	790	0.787	1	622
		EMERG SHUT-DOWN & VENT SWITCHES	EA	147	0.787	2	231
		LIGHTS & RECEPTACLES	SF	2.60	0.787	0	0
							9811
				CONTINGENCY			1.20
				TOTAL			11773

COMMENTS:

1. REFRIGERANT - 1200# OF R-11 / MECH ROOM ABOVE GRADE
2. THREE CHILLERS IN ROOM WITH GAS-FIRED BOILERS AND AIR HANDLING UNITS
3. EASY TO ISOLATE THE CHILLER #3, OTHER TWO VERY DIFFICULT
4. RECOMMEND COMBINING ALL UNITS INTO ONE CHILLER WHEN CHILLERS ARE REPLACED

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Table I-5. Calculation of Cost to Upgrade Mechanical Rooms

PLANT BLDG NO	ITEM	DESCRIPTION	UNIT	UNIT COST	COST ADJUST (AUSTIN)	QTY	TOTAL COST
87018	1	FOUNDATIONS					
		FOUNDATION & FOOTINGS	SF	7.20	0.884	0	0
		EXCAVATION & BACKFILL	SF	1.59	0.884	0	0
	2	SUBSTRUCTURE					
		6" SLAB ON GRADE, GRAV, VAP BAR	SF	6.03	0.884	0	0
		DEMOLISH HOUSEKEEPING PAD	SF	2.19	0.884	0	0
	3	SUPERSTRUCTURE					
		STEEL FRAMING	SF	4.10	0.936	0	0
		ROOF, OPEN WEB JOIST, STL DECK	SF	2.93	0.936	0	0
	4	EXTERIOR CLOSURE					
		CONCRETE BLOCK WALL, PTD	SF	9.83	0.812	0	0
	5	ROOFING					
		TAR & GRAVEL W/ INSULATION	SF	3.36	0.789	0	0
	6	INTERIOR					
		HOLLOW METAL DOOR, 1-HR	EA	1059	0.918	0	0
		PARTITION, STL STUD / GYP, 1-HR, PTD	SF	4.13	0.818	264	892
	7	MECHANICAL VENTILATION					
		EXHAUST FAN, ROOF CENTRIFUGAL	EA	1500	0.874	1	1311
		INTAKE LOUVER	SF	41	0.874	9.3	333
		DUCT DAMPER, 36x16	EA	166	0.874	1	145
		DUCTWORK	LB	6.10	0.874	142	757
		REVISE DUCTWORK	LB	6.10	0.874	0	0
		RELOCATE LOUVER	SF	16	0.874	0	0
	8	CONTROLS					
		DAMPER ACTUATOR, 120V-1PH	EA	259	0.874	1	226
		THERMOSTAT, 120V-1PH	EA	65	0.874	1	57
		REFRIGERATION SENSOR/ALARM	EA	1200	0.874	1	1049
	9	ELECTRICAL					
		WIRE & CONDUIT, 1 HP FAN MOTOR	EA	820	0.787	1	645
		EMERG SHUT-DOWN & VENT SWITCHES	EA	147	0.787	2	231
		LIGHTS & RECEPTACLES	SF	2.60	0.787	0	0
							5646
				CONTINGENCY			1.20
COMMENTS:				TOTAL			6775

1. REFRIGERANT = 1760# OF R-11 / MECH ROOM ABOVE GRADE
2. TWO CHILLERS IN ROOM WITH GAS-FIRED BOILERS
3. VERY EASY TO ISOLATE THE CHILLER

PLANT BLDG NO	ITEM	DESCRIPTION	UNIT	UNIT COST	COST ADJUST (AUSTIN)	QTY	TOTAL COST
91001	1	FOUNDATIONS					
		FOUNDATION & FOOTINGS	SF	7.20	0.884	0	0
		EXCAVATION & BACKFILL	SF	1.59	0.884	0	0
	2	SUBSTRUCTURE					
		6" SLAB ON GRADE, GRAV, VAP BAR	SF	6.03	0.884	0	0
		DEMOLISH HOUSEKEEPING PAD	SF	2.19	0.884	0	0
	3	SUPERSTRUCTURE					
		STEEL FRAMING	SF	4.10	0.936	0	0
		ROOF, OPEN WEB JOIST, STL DECK	SF	2.93	0.936	0	0
	4	EXTERIOR CLOSURE					
		CONCRETE BLOCK WALL, PTD	SF	9.83	0.812	0	0
	5	ROOFING					
		TAR & GRAVEL W/ INSULATION	SF	3.36	0.789	0	0
	6	INTERIOR					
		HOLLOW METAL DOOR, 1-HR	EA	1059	0.918	1	972
		PARTITION, STL STUD / GYP, 1-HR, PTD	SF	4.13	0.818	120	405
	7	MECHANICAL VENTILATION					
		EXHAUST FAN, ROOF CENTRIFUGAL	EA	1025	0.874	1	896
		INTAKE LOUVER	SF	41	0.874	5.5	197
		DUCT DAMPER, 20x16	EA	77	0.874	1	67
		DUCTWORK	LB	6.10	0.874	100	533
		REVISE DUCTWORK	LB	6.10	0.874	0	0
		RELOCATE LOUVER	SF	16	0.874	0	0
	8	CONTROLS					
		DAMPER ACTUATOR, 120V-1PH	EA	259	0.874	1	226
		THERMOSTAT, 120V-1PH	EA	65	0.874	1	57
		REFRIGERATION SENSOR/ALARM	EA	1200	0.874	1	1049
	9	ELECTRICAL					
		WIRE & CONDUIT, 1/3 HP FAN MOTOR	EA	775	0.787	1	610
		EMERG SHUT-DOWN & VENT SWITCHES	EA	147	0.787	2	231
		LIGHTS & RECEPTACLES	SF	2.60	0.787	0	0
							5243
				CONTINGENCY			1.20
COMMENTS:				TOTAL			6292

1. MECH ROOM IN BASEMENT ORIGINALLY HOUSED CHILLER
2. NEW CHILLER MUST BE SEPARATED FROM GAS-FIRED BOILERS
3. VENTILATION REVISION DIFFICULT

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Table I-6. ECO-1 Summary of Chiller Energy and Cost for Existing Conditions

PLANT NO	PLANT BLDG NO	PLANT HAP CALC LOAD	OPER SCHED	PLANT EXIST CAP	PLANT EXIST MAX OUTPUT	PLANT EXIST PEAK DEMAND	PLANT EXIST CONSUMP	PLANT EXIST ENERGY COST	PLANT EXIST UNIT OUTPUT COST
		TONS	HR/YR	TONS	TONS	KW	KWH/YR	$/YR	$/TON*YR
1	121	138	4380	200.0	155.9	126.5	244094	25162	161
2	135	91	4380	128.4	102.8	89.5	165926	17640	172
3	194	107	4380	228.0	120.9	91.5	195214	18648	154
5	410	238	4380	220.0	220.0	158.0	371264	33021	150
6	2805	116	4380	149.8	131.1	115.9	216891	22892	175
7	5764	201	4380	249.6	237.3	227.9	406474	44533	188
8	5792	176	4380	170.0	170.0	157.0	351948	32405	191
9	7050	306	8760	420.0	345.8	308.8	744803	64998	188
10	7051	158	8760	170.0	170.0	121.0	303324	25744	151
13	14020	154	4380	140.4	140.4	119.4	285585	25074	179
14	14023	166	4380	146.0	146.0	124.2	309229	26374	181
15	21002	240	4380	215.0	215.0	188.0	458564	39694	185
16	27004	486	4380	465.0	465.0	408.0	925004	84461	182
17	28000	238	4380	220.0	220.0	170.0	399563	35532	162
18	29005	836	4380	948.0	944.7	800.0	1517496	158500	168
19	31008	458	4380	460.0	460.0	301.0	645220	61418	134
20	34008	485	4380	460.0	460.0	301.0	688184	62449	136
21	36000	1155	8760	1277.0	1277.0	870.0	2151556	184399	144
22	36006	259	4380	275.0	275.0	185.0	370301	37118	135
23	36009	110	4380	95.5	95.5	95.5	243532	20418	214
24	36014	96	8760	96.2	96.2	87.6	218801	18619	194
25	39015	980	4380	1215.0	1107.4	847.3	1576413	167132	151
26	39043	1084	4380	1120.0	1120.0	905.0	1902924	183773	164
27	41003	232	4380	227.5	227.5	199.0	436832	40851	180
28	42000	189	4380	209.0	209.0	190.0	361850	37678	180
29	50001	129	8760	129.2	129.2	129.2	366147	28503	221
30	50004	306	8760	375.0	345.8	293.8	705962	61777	179
31	87018	902	4380	948.0	948.0	800.0	1653448	161763	171
32	91001	123	4380	121.8	121.8	121.8	266784	24989	205
		10159		11079.4	10657.3	8531.9	18483333	1745565	164

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Table I-7. ECO-1 Summary of Chiller Energy and Cost for New Conditions

PLANT NO	PLANT BLDG NO	PLANT HAP CALC LOAD	OPER SCHED	PLANT NEW CAP	PLANT NEW/ EXIST CAP	PLANT NEW MAX OUTPUT	PLANT NEW PEAK DEMAND	PLANT NEW CONSUMP	PLANT NEW ENERGY COST	PLANT NEW UNIT OUTPUT COST
		TONS	HR/YR	TONS	%	TONS	KW	KWH/YR	$/YR	$/TON*YR
1	121	138	4380	138.0	69	138.0	91.8	196855	18733	136
2	135	91	4380	91.0	71	91.0	77.1	166771	15768	173
3	194	107	4380	107.0	47	107.0	91.5	197909	18713	175
5	410	238	4380	238.0	108	219.0	144.2	349943	30404	139
6	2805	116	4380	116.0	77	116.0	99.6	215406	20369	176
7	5764	201	4380	201.0	81	201.0	136.8	293284	27914	139
8	5792	176	4380	170.0	100	170.0	113.2	253789	23365	137
9	7050	306	8760	306.0	73	306.0	200.6	544903	43689	143
10	7051	158	8760	158.0	93	158.0	104.1	282469	22665	143
13	14020	154	4380	154.0	110	140.1	86.9	215098	18423	131
14	14023	166	4380	166.0	114	146.1	90.4	233845	19407	133
15	21002	240	4380	240.0	112	216.0	144.0	360388	30624	142
16	27004	486	4380	465.0	100	465.0	273.6	620266	56638	122
17	28000	238	4380	238.0	108	219.0	144.2	349943	30404	139
18	29005	836	4380	853.2	90	853.2	495.6	1055933	100971	118
19	31008	458	4380	460.0	SAME	460.0	301.0	645220	61418	134
20	34008	485	4380	460.0	SAME	460.0	301.0	688184	62449	136
21	36000	1155	8760	1277.1	100	1277.1	741.6	1917874	159197	125
22	36006	259	4380	275.0	100	275.0	187.5	375388	37622	137
23	36009	110	4380	95.5	SAME	95.5	95.5	243532	20418	214
24	36014	96	8760	96.2	100	96.2	81.8	204364	17387	181
25	39015	980	4380	980.0	81	980.0	580.6	1268308	119039	121
26	39043	1084	4380	1120.0	100	1120.0	688.4	1447552	139791	125
27	41003	232	4380	227.5	100	227.5	157.4	345409	32309	142
28	42000	189	4380	188.1	90	188.1	127.0	272207	25913	138
29	50001	129	8760	129.2	100	129.2	87.2	253197	19383	150
30	50004	306	8760	306.0	82	306.0	198.0	574802	44010	144
31	87018	902	4380	948.0	100	948.0	559.2	1148831	112906	119
32	91001	123	4380	121.8	100	121.8	83.3	180890	17053	140
		10159		10325.6	93	10229.8	6483.1	14902560	1346982	132

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Table I-8. ECO-1 Summary of Construction Costs

PLANT NO	PLANT BLDG NO	REPLACE/ DEMOLISH CHILLER COST $	REPLACE/ DEMOLISH TOWER EXT COST $	REPLACE/ DEMOLISH PUMP(S) EXT COST $	REPLACE/ DEMOLISH PIPE/COND EXT COST $	REPLACE CHILLER PAYBACK COST $	REPLACE CHILLER PAYBACK COST $	REPLACE CHILLER PAYBK w/ REB YRS	REPLACE/ DEMOLISH CHILLER EXT COST $	REPLACE/ DEMOLISH TOWER EXT COST $	REPLACE/ DEMOLISH PUMP(S) EXT COST $	REPLACE/ DEMOLISH PIPE/COND EXT COST $	UPGRADE BLDG EXT COST $	REPLACE CHILLER PAYBACK COST $	REPLACE CHILLER PAYBACK COST $	REPLACE CHILLER PAYBK w/ REB YRS
1	121	108204	0	0	0	108204	108204	16.4	0	3400	0	6578	20760	138942	138942	21.2
2	135	48883	0	6812	1959	57654	59599	30.7	0	13380	8258	3791	7438	90521	94433	49.3
	135	1945	0	0	0	1945	0	0	0	442	1172	353	0	3912	-	-
3	194	72928	0	0	0	72928	72928	NONE	0	3876	0	0	10794	87598	87598	NONE
5	410	96705	0	0	0	96705	193410	72.4	0	0	0	0	10762	107467	204172	76.5
	410	96705	0	0	0	96705	0	0	0	0	0	0	0	96705	-	-
6	2805	69173	0	0	0	69173	69173	27.0	0	2547	0	3159	14446	89325	89325	35.0
7	5764	134139	19905	0	0	154044	158951	9.3	0	0	0	0	6888	160932	165839	9.8
	5764	2965	0	0	1942	4907	0	0	0	0	0	0	0	4907	-	-
8	5792	124986	0	0	0	124986	124986	13.4	0	2890	0	0	7386	135262	135262	14.6
9	7050	115501	0	0	0	115501	231002	10.5	0	3570	0	0	9797	128868	247939	11.3
	7050	115501	0	0	0	115501	0	0	0	3570	0	0	0	119071	-	-
10	7051	115831	0	0	0	115831	115831	36.5	0	2890	0	0	9552	128273	128273	40.6
	7051	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-
13	14020	117289	0	0	0	117289	117289	17.1	0	18741	0	0	8136	144166	144166	21.2
14	14023	121973	0	0	0	121973	121973	17.0	0	19144	0	0	8136	149253	149253	20.9
15	21002	133909	0	0	0	133909	133909	14.5	0	22888	0	8109	23610	188516	188516	20.5
16	27004	203561	0	0	0	203561	203561	6.8	0	7905	0	0	8960	220426	220426	7.4
17	28000	96705	0	0	0	96705	193410	36.9	0	0	0	0	10620	107325	204030	39.0
	28000	96705	0	0	0	96705	0	0	0	0	0	0	0	96705	-	-
18	29005	196017	0	0	0	196017	392034	6.3	0	8704	0	0	9108	213829	417258	6.8
	29005	196017	0	0	0	196017	0	0	0	7412	0	0	0	203429	-	-
19	31008	0	0	0	0	0	0	NONE	0	7820	0	0	0	7820	7820	NONE
20	34008	0	0	0	0	0	0	NONE	0	7820	0	0	0	7820	7820	NONE
21	36000	194335	0	0	0	194335	584445	21.5	0	6800	0	0	28042	229177	634196	23.5
	36000	194335	0	0	0	194335	0	0	0	6800	0	0	0	201135	-	-
	36000	195775	0	0	0	195775	0	0	0	8109	0	0	0	203884	-	-
22	36006	145654	0	0	0	145654	145654	NONE	0	4675	7029	0	11215	168573	168573	NONE
23	36009	0	0	0	0	0	0	NONE	0	0	0	0	0	0	5223	NONE
	36014	0	0	0	0	0	0	0	3698	0	1172	353	0	5223	-	-
24	36014	55220	0	0	0	55220	55220	43.1	0	1635	1172	4259	6292	68578	68578	53.9
25	39015	209308	0	0	0	209308	418616	8.1	0	10727	0	5416	10154	235605	460257	8.9
	39015	209308	0	0	0	209308	0	0	0	9928	0	5416	0	224652	-	-
26	39043	224947	0	0	0	224947	449894	9.5	0	9520	0	0	7261	241728	476195	10.1
	39043	224947	0	0	0	224947	0	0	0	9520	0	0	0	234467	-	-
27	41003	131135	0	0	0	131135	131135	14.9	0	3868	0	8109	9110	152222	152222	17.4
28	42000	122751	0	0	0	122751	122751	10.1	0	3553	0	3934	7417	137655	137655	11.4
29	50001	100749	17569	10308	11212	139838	139838	15.1	0	0	0	0	9443	149281	149281	16.1
30	50004	150175	0	0	0	150175	164895	8.9	0	2125	26547	20375	11773	210995	235237	12.8
	50004	7360	0	0	0	7360	0	0	0	2125	2636	0	0	12121	-	-
	50004	7360	0	0	0	7360	0	0	0	2125	2636	0	0	12121	-	-
31	87018	204754	0	0	0	204754	409508	7.8	0	8704	0	0	6775	220233	432399	8.2
	87018	204754	0	0	0	204754	0	0	0	7412	0	0	0	212166	-	-
32	91001	102060	17314	10308	15348	145030	145030	18.0	0	0	0	0	6292	151322	151322	18.8
		4950569	54788	27428	30461	5063246	5063246		3698	234625	50622	69852	280167	5702210	5702210	

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Table I-9. ECO-1 Calculation of Simple Payback Periods (by Plant)

PLANT NO	PLANT BLDG NO	PLANT HAP CALC LOAD	OPER SCHED	PLANT EXIST CAP	PLANT NEW CAP	PLANT NEW/ EXIST CAP	PLANT PEAK DEMAND SAVED		PLANT CONSUMP SAVED		PLANT ENERGY COST SAVED		PLANT UTIL REBATE	REPLACE CHILLER		REPLACE CHILLER	
														PAYBACK COST	PAYBK w/ REB	PAYBACK COST	PAYBK w/ REB
		TONS	HR/YR	TONS	TONS	%	KW/YR	%	KWH/YR	%	$/YR	%	$	$	YRS	$	YRS
1	121	138	4380	200.0	138.0	69	34.7	27	47239	19	6429	26	2790	108204	16.4	138942	21.2
2	135	91	4380	128.4	91.0	71	12.4	14	-845	-1	1872	11	2085	59599	30.7	94433	49.3
3	194	107	4380	228.0	107.0	47	0.0	0	-2695	-1	-65	0	1015	72928	NONE	87598	NONE
5	410	238	4380	220.0	238.0	108	13.8	9	21321	6	2617	8	3990	193410	72.4	204172	76.5
6	2805	116	4380	149.8	116.0	77	16.3	14	1485	1	2523	11	1060	69173	27.0	89325	35.0
7	5764	201	4380	249.6	201.0	81	91.1	40	113190	28	16619	37	3600	158951	9.3	165839	9.8
8	5792	176	4380	170.0	170.0	100	43.8	28	98159	28	9040	28	3420	124986	13.4	135262	14.6
9	7050	306	8760	420.0	306.0	73	108.2	35	199900	27	21309	33	6630	231002	10.5	247939	11.3
10	7051	158	8760	170.0	158.0	93	16.9	14	20855	7	3079	12	3345	115831	36.5	128273	40.6
13	14020	154	4380	140.4	154.0	110	32.5	27	70487	25	6651	27	3330	117289	17.1	144166	21.2
14	14023	166	4380	146.0	166.0	114	33.8	27	75384	24	6967	26	3390	121973	17.0	149253	20.9
15	21002	240	4380	215.0	240.0	112	44.0	23	98176	21	9070	23	2260	133909	14.5	188516	20.5
16	27004	486	4380	465.0	465.0	100	134.4	33	304738	33	27823	33	14760	203561	6.8	220426	7.4
17	28000	238	4380	220.0	238.0	108	25.8	15	49620	12	5128	14	3990	193410	36.9	204030	39.0
18	29005	836	4380	948.0	853.2	90	304.4	38	461563	30	57529	36	28044	392034	6.3	417258	6.8
19	31008	458	4380	460.0	460.0	SAME	0.0	0	0	0	0	0	-	0	NONE	7820	NONE
20	34008	485	4380	460.0	460.0	SAME	0.0	0	0	0	0	0	-	0	NONE	7820	NONE
21	36000	1155	8760	1277.0	1277.1	100	128.4	15	233682	11	25202	14	42012	584445	21.5	634196	23.5
22	36006	259	4380	275.0	275.0	100	-2.5	-1	-5087	-1	-504	-1	4875	145654	NONE	168573	NONE
23	36009	110	4380	95.5	95.5	SAME	0.0	0	0	0	0	0	-	0	NONE	5223	NONE
24	36014	96	8760	96.2	96.2	100	5.8	7	14437	7	1232	7	2160	55220	43.1	68578	53.9
25	39015	980	4380	1215.0	980.0	81	266.7	31	308105	20	48093	29	30510	418616	8.1	460257	8.9
26	39043	1084	4380	1120.0	1120.0	100	216.6	24	455372	24	43982	24	31140	449894	9.5	476195	10.1
27	41003	232	4380	227.5	227.5	100	41.6	21	91423	21	8542	21	3690	131135	14.9	152222	17.4
28	42000	189	4380	209.0	188.1	90	63.0	33	89643	25	11765	31	3522	122751	10.1	137655	11.4
29	50001	129	8760	129.2	129.2	100	42.0	33	112950	31	9120	32	2424	139838	15.1	149281	16.1
30	50004	306	8760	375.0	306.0	82	95.8	33	131160	19	17767	29	7020	164895	8.9	235237	12.8
31	87018	902	4380	948.0	948.0	100	240.8	30	504617	31	48857	30	29880	409508	7.8	432399	8.2
32	91001	123	4380	121.8	121.8	100	38.5	32	85894	32	7936	32	2121	145030	18.0	151322	18.8
		10159		11079.4	10325.6	93	2048.8	24	3580773	19	398583	23	243063	5063246		5702210	

APPENDIX I

Table I-10. ECO-1 Calculation of Simple Payback Periods (by Payback)

PLANT NO	PLANT BLDG NO	PLANT HAP CALC LOAD	OPER SCHED	PLANT EXIST CAP	PLANT NEW CAP	PLANT NEW/ EXIST CAP	PLANT PEAK DEMAND SAVED		PLANT CONSUMP SAVED		PLANT ENERGY COST SAVED		PLANT UTIL REBATE	REPLACE CHILLER		REPLACE CHILLER	
														PAYBACK COST	PAYBK w/ REB	PAYBACK COST	PAYBK w/ REB
		TONS	HR/YR	TONS	TONS	%	KW/YR	%	KWH/YR	%	$/YR	%	$	$	YRS	$	YRS
18	29005	836	4380	948.0	853.2	90	304.4	38	461563	30	57529	36	28044	392034	6.3	417258	6.8
16	27004	486	4380	465.0	465.0	100	134.4	33	304738	33	27823	33	14760	203561	6.8	220426	7.4
31	87018	902	4380	948.0	948.0	100	240.8	30	504617	31	48857	30	29880	409508	7.8	432399	8.2
25	39015	980	4380	1215.0	980.0	81	266.7	31	308105	20	48093	29	30510	418616	8.1	460257	8.9
30	50004	306	8760	375.0	306.0	82	95.8	33	131160	19	17767	29	7020	164895	8.9	235237	12.8
7	5764	201	4380	249.6	201.0	81	91.1	40	113190	28	16619	37	3600	158951	9.3	165839	9.8
26	39043	1084	4380	1120.0	1120.0	100	216.6	24	455372	24	43982	24	31140	449894	9.5	476195	10.1
28	42000	189	4380	209.0	188.1	90	63.0	33	89643	25	11765	31	3522	122751	10.1	137655	11.4
9	7050	306	8760	420.0	306.0	73	108.2	35	199900	27	21309	33	6630	231002	10.5	247939	11.3
8	5792	176	4380	170.0	170.0	100	43.8	28	98159	28	9040	28	3420	124986	13.4	135262	14.6
15	21002	240	4380	215.0	240.0	112	44.0	23	98176	21	9070	23	2260	133909	14.5	188516	20.5
27	41003	232	4380	227.5	227.5	100	41.6	21	91423	21	8542	21	3690	131135	14.9	152222	17.4
29	50001	129	8760	129.2	129.2	100	42.0	33	112950	31	9120	32	2424	139838	15.1	149281	16.1
1	121	138	4380	200.0	138.0	69	34.7	27	47239	19	6429	26	2790	108204	16.4	138942	21.2
14	14023	166	4380	146.0	166.0	114	33.8	27	75384	24	6967	26	3390	121973	17.0	149253	20.9
13	14020	154	4380	140.4	154.0	110	32.5	27	70487	25	6651	27	3330	117289	17.1	144166	21.2
32	91001	123	4380	121.8	121.8	100	38.5	32	85894	32	7936	32	2121	145030	18.0	151322	18.8
21	36000	1155	8760	1277.0	1277.1	100	128.4	15	233682	11	25202	14	42012	584445	21.5	634196	23.5
6	2805	116	4380	149.8	116.0	77	16.3	14	1485	1	2523	11	1060	69173	27.0	89325	35.0
2	135	91	4380	128.4	91.0	71	12.4	14	-845	-1	1872	11	2085	59599	30.7	94433	49.3
10	7051	158	8760	170.0	158.0	93	16.9	14	20855	7	3079	12	3345	115831	36.5	128273	40.6
17	28000	238	4380	220.0	238.0	108	25.8	15	49620	12	5128	14	3990	193410	36.9	204030	39.0
24	36014	96	8760	96.2	96.2	100	5.8	7	14437	7	1232	7	2160	55220	43.1	68578	53.9
5	410	238	4380	220.0	238.0	108	13.8	9	21321	6	2617	8	3990	193410	72.4	204172	76.5
3	194	107	4380	228.0	107.0	47	0.0	0	-2695	-1	-65	0	1015	72928	NONE	87598	NONE
19	31008	458	4380	460.0	460.0	SAME	0.0	0	0	0	0	0	-	0	NONE	7820	NONE
20	34008	485	4380	460.0	460.0	SAME	0.0	0	0	0	0	0	-	0	NONE	7820	NONE
22	36006	259	4380	275.0	275.0	100	-2.5	-1	-5087	-1	-504	-1	4875	145654	NONE	168573	NONE
23	36009	110	4380	95.5	95.5	SAME	0.0	0	0	0	0	0	-	0	NONE	5223	NONE
		10159		11079.4	10325.6	93	2048.8	24	3580773	19	398583	23	243063	5063246		5702210	

Appendix J: ECO-2 (Install Variable Speed Drives for Chillers)

APPENDIX J

Table J-1. ECO-2 Calculation of Chiller Energy Cost for New Conditions.

PLANT NO:	5		MASTER CHILLER NO (LEAD):	6		MASTER CHILLER NO (LAG 1):	7	
BUILDING NO:	410							
DESIGN LOAD:	238	TONS	COMPRESSOR:	CENT	W/ TURBO	COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER		CONDENSER:	WATER	
SIMULATION MODEL:	EQ-2M		REFRIGERANT:	R-123		REFRIGERANT:	R-123	
			STATUS:	NEW		STATUS:	NEW	
PEAK DEMAND:	160.5	KW						
CONSUMPTION:	316414	KWH/YR	CONFIGURATION:	PARALLEL		CONFIGURATION:	PARALLEL	
			MAX LEAD SETPT or PRO-RATE LOAD:	85	%	MIN LAG SETPOINT:	NA	%
DEMAND COST:	$24,492	/YR	LOAD LIMIT:	95	%	LOAD LIMIT:	100	%
ENERGY COST:	$7,594	/YR						
TOTAL COST:	$32,086	/YR	RATED CAPACITY:	119.0	TONS	RATED CAPACITY:	119.0	TONS
			RATED POWER:	81.9	KW	RATED POWER:	81.9	KW
UNIT OUTPUT COST:	$138	/TON*YR	RATED EFFICIENCY:	0.688	KW/TON	RATED EFFICIENCY:	0.688	KW/TON

% PLANT DSGN LOAD	PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%	TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR	TONS	%	%	%	KW	HR/YR	KWH/YR
0 W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0	0.0	0	0	0	0.0	0	0
3 S	7.1	0.0	37	1.6	7.1	6	15	2	1.6	15	24	0.0	0	0	0	0.0	0	0
8 S	19.0	0.0	50	1.6	19.0	16	16	2	1.6	50	80	0.0	0	0	0	0.0	0	0
13 S	30.9	0.0	65	5.7	30.9	26	26	7	5.7	65	371	0.0	0	0	0	0.0	0	0
18 S	42.8	0.0	83	10.6	42.8	36	36	13	10.6	83	880	0.0	0	0	0	0.0	0	0
23 S	54.7	0.0	106	18.0	54.7	46	46	22	18.0	106	1908	0.0	0	0	0	0.0	0	0
28 S	66.6	0.0	143	27.0	66.6	56	56	33	27.0	143	3861	0.0	0	0	0	0.0	0	0
33 S	78.5	0.0	184	37.7	78.5	66	66	46	37.7	184	6937	0.0	0	0	0	0.0	0	0
38 S	90.4	0.0	232	50.0	90.4	76	76	61	50.0	232	11600	0.0	0	0	0	0.0	0	0
43 S	102.3	0.0	259	45.1	51.2	43	43	19	15.6	259	4040	51.1	43	43	36	29.5	259	7641
48 S	114.2	0.0	292	52.5	57.1	48	48	24	19.7	292	5752	57.1	48	48	40	32.8	292	9578
53 S	126.1	0.0	343	59.8	63.1	53	53	29	23.8	343	8163	63.0	53	53	44	36.0	343	12348
58 S	138.0	0.0	381	68.8	69.0	58	58	35	28.7	381	10935	69.0	58	58	49	40.1	381	15278
63 S	149.9	0.0	388	78.6	75.0	63	63	42	34.4	388	13347	74.9	63	63	54	44.2	388	17150
68 S	161.8	0.0	374	88.4	80.9	68	68	49	40.1	374	14997	80.9	68	68	59	48.3	374	18064
73 S	173.7	0.0	357	98.3	86.9	73	73	56	45.9	357	16386	86.8	73	73	64	52.4	357	18707
78 S	185.6	0.0	308	110.5	92.8	78	78	65	53.2	308	16386	92.8	78	78	70	57.3	308	17648
83 S	197.5	0.0	247	122.0	98.8	83	83	73	59.8	247	14771	98.7	83	83	76	62.2	247	15363
88 S	209.4	0.0	171	135.2	104.7	88	88	83	68.0	171	11628	104.7	88	88	82	67.2	171	11491
93 S	221.3	0.0	109	148.2	110.7	93	93	92	75.3	109	8208	110.6	93	93	89	72.9	109	7946
98 S	233.2	1.1	59	160.5	113.1	95	95	96	78.6	59	4637	119.0	100	100	100	81.9	59	4832
103 S	245.1	13.0	25	160.5	113.1	95	95	96	78.6	25	1965	119.0	100	100	100	81.9	25	2048
108 S	257.0	24.9	7	160.5	113.1	95	95	96	78.6	7	550	119.0	100	100	100	81.9	7	573
113 S	268.9	36.8	2	160.5	113.1	95	95	96	78.6	2	157	119.0	100	100	100	81.9	2	164
118 S	280.8	48.7	0	160.5	113.1	95	95	96	78.6	0	0	119.0	100	100	100	81.9	0	0
			8602							4200	157583						3322	158831

PLANT NO:	7		MASTER CHILLER NO (LEAD):	9	
BUILDING NO:	5764				
DESIGN LOAD:	201 E	TONS	COMPRESSOR:	CENT	W/ TURBO
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-123	
			STATUS:	NEW	
PEAK DEMAND:	131.3	KW			
CONSUMPTION:	230672	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$20,036	/YR	LOAD LIMIT:	95	%
ENERGY COST:	$5,536	/YR			
TOTAL COST:	$25,573	/YR	RATED CAPACITY:	201.0	TONS
			RATED POWER:	136.8	KW
UNIT OUTPUT COST:	$134	/TON*YR	RATED EFFICIENCY:	0.681	KW/TON

% PLANT DSGN LOAD	PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%	TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
0 W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3 S	6.0	0.0	37	2.7	6.0	3	15	2	2.7	7	19
8 S	16.1	0.0	50	2.7	16.1	8	15	2	2.7	27	73
13 S	26.1	0.0	65	2.7	26.1	13	15	2	2.7	56	151
18 S	36.2	0.0	83	4.1	36.2	18	18	3	4.1	83	340
23 S	46.2	0.0	106	6.8	46.2	23	23	5	6.8	106	721
28 S	56.3	0.0	143	10.9	56.3	28	28	8	10.9	143	1559
33 S	66.3	0.0	184	15.0	66.3	33	33	11	15.0	184	2760
38 S	76.4	0.0	232	20.5	76.4	38	38	15	20.5	232	4756
43 S	86.4	0.0	259	26.0	86.4	43	43	19	26.0	259	6734
48 S	96.5	0.0	292	32.8	96.5	48	48	24	32.8	292	9578
53 S	106.5	0.0	343	39.7	106.5	53	53	29	39.7	343	13617
58 S	116.6	0.0	381	47.9	116.6	58	58	35	47.9	381	18250
63 S	126.6	0.0	388	57.5	126.6	63	63	42	57.5	388	22310
68 S	136.7	0.0	374	67.0	136.7	68	68	49	67.0	374	25058
73 S	146.7	0.0	357	76.6	146.7	73	73	56	76.6	357	27346
78 S	156.8	0.0	308	88.9	156.8	78	78	65	88.9	308	27381
83 S	166.8	0.0	247	99.9	166.8	83	83	73	99.9	247	24675
88 S	176.9	0.0	171	113.5	176.9	88	88	83	113.5	171	19409
93 S	186.9	0.0	109	125.9	186.9	93	93	92	125.9	109	13723
98 S	197.0	6.0	59	131.3	191.0	95	95	96	131.3	59	7747
103 S	207.0	16.0	25	131.3	191.0	95	95	96	131.3	25	3283
108 S	217.1	26.1	7	131.3	191.0	95	95	96	131.3	7	919
113 S	227.1	36.1	2	131.3	191.0	95	95	96	131.3	2	263
118 S	237.2	46.2	0	131.3	191.0	95	95	96	131.3	0	0
			8602							4160	230672

APPENDIX J

Table J-1. ECO-2 Calculation of Chiller Energy Cost for New Conditions.

PLANT NO:	9		MASTER CHILLER NO (LEAD):	12			MASTER CHILLER NO (LAG 1):	13	
BUILDING NO:	7050								
DESIGN LOAD:	306	TONS	COMPRESSOR:	CENT	W/ TURBO		COMPRESSOR:	CENT	
WINTER LOAD:	15	%DSGN	CONDENSER:	WATER			CONDENSER:	WATER	
SIMULATION MODEL:	EQ-2M		REFRIGERANT:	R-123			REFRIGERANT:	R-123	
			STATUS:	NEW			STATUS:	NEW	
PEAK DEMAND:	196.6	KW							
CONSUMPTION:	426890	KWH/YR	CONFIGURATION:	PARALLEL			CONFIGURATION:	PARALLEL	
			MAX LEAD SETPT or PRO-RATE LOAD:	85	%		MIN LAG SETPOINT:	NA	%
DEMAND COST:	$30,001	/YR	LOAD LIMIT:	95	%		LOAD LIMIT:	100	%
ENERGY COST:	$10,245	/YR							
TOTAL COST:	$40,247	/YR	RATED CAPACITY:	153.0	TONS		RATED CAPACITY:	153.0	TONS
			RATED POWER:	100.3	KW		RATED POWER:	100.3	KW
UNIT OUTPUT COST:	$135	/TON*YR	RATED EFFICIENCY:	0.656	KW/TON		RATED EFFICIENCY:	0.656	KW/TON

% PLANT DSGN LOAD	PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%	TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR	TONS	%	%	%	KW	HR/YR	KWH/YR
15 W	45.9	0.0	4380	9.0	45.9	30	30	9	9.0	4380	39420	0.0	0	0	0	0.0	0	0
3 S	9.2	0.0	37	2.0	9.2	6	15	2	2.0	15	30	0.0	0	0	0	0.0	0	0
8 S	24.5	0.0	50	2.0	24.5	16	16	2	2.0	50	100	0.0	0	0	0	0.0	0	0
13 S	39.8	0.0	65	7.0	39.8	26	26	7	7.0	65	455	0.0	0	0	0	0.0	0	0
18 S	55.1	0.0	83	13.0	55.1	36	36	13	13.0	83	1079	0.0	0	0	0	0.0	0	0
23 S	70.4	0.0	106	22.1	70.4	46	46	22	22.1	106	2343	0.0	0	0	0	0.0	0	0
28 S	85.7	0.0	143	33.1	85.7	56	56	33	33.1	143	4733	0.0	0	0	0	0.0	0	0
33 S	101.0	0.0	184	46.1	101.0	66	66	46	46.1	184	8482	0.0	0	0	0	0.0	0	0
38 S	116.3	0.0	232	61.2	116.3	76	76	61	61.2	232	14198	0.0	0	0	0	0.0	0	0
43 S	131.6	0.0	259	55.2	65.8	43	43	19	19.1	259	4947	65.8	43	43	36	36.1	259	9350
48 S	146.9	0.0	292	64.2	73.5	48	48	24	24.1	292	7037	73.4	48	48	40	40.1	292	11709
53 S	162.2	0.0	343	73.2	81.1	53	53	29	29.1	343	9981	81.1	53	53	44	44.1	343	15126
58 S	177.5	0.0	381	84.2	88.8	58	58	35	35.1	381	13373	88.7	58	58	49	49.1	381	18707
63 S	192.8	0.0	388	96.3	96.4	63	63	42	42.1	388	16335	96.4	63	63	54	54.2	388	21030
68 S	208.1	0.0	374	108.3	104.1	68	68	49	49.1	374	18363	104.0	68	68	59	59.2	374	22141
73 S	223.4	0.0	357	120.4	111.7	73	73	56	56.2	357	20063	111.7	73	73	64	64.2	357	22919
78 S	238.7	0.0	308	135.4	119.4	78	78	65	65.2	308	20082	119.3	78	78	70	70.2	308	21622
83 S	254.0	0.0	247	149.4	127.0	83	83	73	73.2	247	18080	127.0	83	83	76	76.2	247	18821
88 S	269.3	0.0	171	165.4	134.7	88	88	83	83.2	171	14227	134.6	88	88	82	82.2	171	14056
93 S	284.6	0.0	109	181.6	142.3	93	93	92	92.3	109	10061	142.3	93	93	89	89.3	109	9734
98 S	299.9	1.5	59	196.6	145.4	95	95	96	96.3	59	5682	153.0	100	100	100	100.3	59	5918
103 S	315.2	16.8	25	196.6	145.4	95	95	96	96.3	25	2408	153.0	100	100	100	100.3	25	2508
108 S	330.5	32.1	7	196.6	145.4	95	95	96	96.3	7	674	153.0	100	100	100	100.3	7	702
113 S	345.8	47.4	2	196.6	145.4	95	95	96	96.3	2	193	153.0	100	100	100	100.3	2	201
118 S	361.1	62.7	0	196.6	145.4	95	95	96	96.3	0	0	153.0	100	100	100	100.3	0	0
			8602							8580	232346						3322	194544

PLANT NO:	15		MASTER CHILLER NO (LEAD):	22	
BUILDING NO:	21002				
DESIGN LOAD:	240	TONS	COMPRESSOR:	CENT	W/ TURBO
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-123	
			STATUS:	NEW	
PEAK DEMAND:	162.6	KW			
CONSUMPTION:	285667	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$24,813	/YR	LOAD LIMIT:	95	%
ENERGY COST:	$6,856	/YR			
TOTAL COST:	$31,669	/YR	RATED CAPACITY:	240.0	TONS
			RATED POWER:	169.4	KW
UNIT OUTPUT COST:	$139	/TON*YR	RATED EFFICIENCY:	0.706	KW/TON

% PLANT DSGN LOAD	PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%	TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
0 W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3 S	7.2	0.0	37	3.4	7.2	3	15	2	3.4	7	24
8 S	19.2	0.0	50	3.4	19.2	8	15	2	3.4	27	92
13 S	31.2	0.0	65	3.4	31.2	13	15	2	3.4	56	190
18 S	43.2	0.0	83	5.1	43.2	18	18	3	5.1	83	423
23 S	55.2	0.0	106	8.5	55.2	23	23	5	8.5	106	901
28 S	67.2	0.0	143	13.6	67.2	28	28	8	13.6	143	1945
33 S	79.2	0.0	184	18.6	79.2	33	33	11	18.6	184	3422
38 S	91.2	0.0	232	25.4	91.2	38	38	15	25.4	232	5893
43 S	103.2	0.0	259	32.2	103.2	43	43	19	32.2	259	8340
48 S	115.2	0.0	292	40.7	115.2	48	48	24	40.7	292	11884
53 S	127.2	0.0	343	49.1	127.2	53	53	29	49.1	343	16841
58 S	139.2	0.0	381	59.3	139.2	58	58	35	59.3	381	22593
63 S	151.2	0.0	388	71.1	151.2	63	63	42	71.1	388	27587
68 S	163.2	0.0	374	83.0	163.2	68	68	49	83.0	374	31042
73 S	175.2	0.0	357	94.9	175.2	73	73	56	94.9	357	33879
78 S	187.2	0.0	308	110.1	187.2	78	78	65	110.1	308	33911
83 S	199.2	0.0	247	123.7	199.2	83	83	73	123.7	247	30554
88 S	211.2	0.0	171	140.6	211.2	88	88	83	140.6	171	24043
93 S	223.2	0.0	109	155.8	223.2	93	93	92	155.8	109	16982
98 S	235.2	7.2	59	162.6	228.0	95	95	96	162.6	59	9593
103 S	247.2	19.2	25	162.6	228.0	95	95	96	162.6	25	4065
108 S	259.2	31.2	7	162.6	228.0	95	95	96	162.6	7	1138
113 S	271.2	43.2	2	162.6	228.0	95	95	96	162.6	2	325
118 S	283.2	55.2	0	162.6	228.0	95	95	96	162.6	0	0
			8602							4160	285667

APPENDIX J

Table J-1. ECO-2 Calculation of Chiller Energy Cost for New Conditions.

PLANT NO:	16		MASTER CHILLER NO (LEAD):	23	
BUILDING NO:	27004				
DESIGN LOAD:	486	TONS	COMPRESSOR:	CENT	W/ TURBO
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-123	
			STATUS:	NEW	
PEAK DEMAND:	262.7	KW			
CONSUMPTION:	501083	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$40,088	/YR	LOAD LIMIT:	95	%
ENERGY COST:	$12,026	/YR			
TOTAL COST:	$52,114	/YR	RATED CAPACITY:	465.0	TONS
			RATED POWER:	273.6	KW
UNIT OUTPUT COST:	$118	/TON*YR	RATED EFFICIENCY:	0.588	KW/TON

% PLANT DSGN LOAD	PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%	TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
0 W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3 S	14.6	0.0	37	5.5	14.6	3	15	2	5.5	7	39
8 S	38.9	0.0	50	5.5	38.9	8	15	2	5.5	27	149
13 S	63.2	0.0	65	5.5	63.2	14	15	2	5.5	61	336
18 S	87.5	0.0	83	8.2	87.5	19	19	3	8.2	83	681
23 S	111.8	0.0	106	16.4	111.8	24	24	6	16.4	106	1738
28 S	136.1	0.0	143	24.6	136.1	29	29	9	24.6	143	3518
33 S	160.4	0.0	184	32.8	160.4	34	34	12	32.8	184	6036
38 S	184.7	0.0	232	46.5	184.7	40	40	17	46.5	232	10788
43 S	209.0	0.0	259	57.5	209.0	45	45	21	57.5	259	14893
48 S	233.3	0.0	292	71.1	233.3	50	50	26	71.1	292	20761
53 S	257.6	0.0	343	84.8	257.6	55	55	31	84.8	343	29086
58 S	281.9	0.0	381	106.7	281.9	61	61	39	106.7	381	40653
63 S	306.2	0.0	388	125.9	306.2	66	66	46	125.9	388	48849
68 S	330.5	0.0	374	145.0	330.5	71	71	53	145.0	374	54230
73 S	354.8	0.0	357	166.9	354.8	76	76	61	166.9	357	59583
78 S	379.1	0.0	308	194.3	379.1	82	82	71	194.3	308	59844
83 S	403.4	0.0	247	221.6	403.4	87	87	81	221.6	247	54735
88 S	427.7	0.0	171	246.2	427.7	92	92	90	246.2	171	42100
93 S	452.0	10.2	109	262.7	441.8	95	95	96	262.7	109	28634
98 S	476.3	34.5	59	262.7	441.8	95	95	96	262.7	59	15499
103 S	500.6	58.8	25	262.7	441.8	95	95	96	262.7	25	6568
108 S	524.9	83.1	7	262.7	441.8	95	95	96	262.7	7	1839
113 S	549.2	107.4	2	262.7	441.8	95	95	96	262.7	2	525
118 S	573.5	131.7	0	262.7	441.8	95	95	96	262.7	0	0
			8602							4165	501083

PLANT NO:	18		MASTER CHILLER NO (LEAD):	27		MASTER CHILLER NO (LAG 1):	26
BUILDING NO:	29005						
DESIGN LOAD:	836	TONS	COMPRESSOR:	CENT	W/ TURBO	COMPRESSOR:	CENT
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER		CONDENSER:	WATER
SIMULATION MODEL:	EQ-2S		REFRIGERANT:	R-123		REFRIGERANT:	R-123
			STATUS:	NEW		STATUS:	NEW
PEAK DEMAND:	485.7	KW					
CONSUMPTION:	941073	KWH/YR	CONFIGURATION:	SERIES/SINGLE		CONFIGURATION:	SERIES/SINGLE
			MAX LEAD SETPT or PRO-RATE LOAD:	85	%	MIN LAG SETPOINT:	70 %
DEMAND COST:	$74,118	/YR	LOAD LIMIT:	95	%	LOAD LIMIT:	100 %
ENERGY COST:	$22,586	/YR					
TOTAL COST:	$96,704	/YR	RATED CAPACITY:	426.6	TONS	RATED CAPACITY:	426.6 TONS
			RATED POWER:	247.8	KW	RATED POWER:	247.8 KW
UNIT OUTPUT COST:	$116	/TON*YR	RATED EFFICIENCY:	0.581	KW/TON	RATED EFFICIENCY:	0.581 KW/TON

% PLANT DSGN LOAD	PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%	TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR	TONS	%	%	%	KW	HR/YR	KWH/YR
0 W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0	0.0	0	0	0	0.0	0	0
3 S	25.1	0.0	37	5.0	25.1	6	15	2	5.0	15	75	0.0	0	0	0	0.0	0	0
8 S	66.9	0.0	50	5.0	66.9	16	16	2	5.0	50	250	0.0	0	0	0	0.0	0	0
13 S	108.7	0.0	65	14.9	108.7	25	25	6	14.9	65	969	0.0	0	0	0	0.0	0	0
18 S	150.5	0.0	83	32.2	150.5	35	35	13	32.2	83	2673	0.0	0	0	0	0.0	0	0
23 S	192.3	0.0	106	52.0	192.3	45	45	21	52.0	106	5512	0.0	0	0	0	0.0	0	0
28 S	234.1	0.0	143	76.8	234.1	55	55	31	76.8	143	10982	0.0	0	0	0	0.0	0	0
33 S	275.9	0.0	184	111.5	275.9	65	65	45	111.5	184	20516	0.0	0	0	0	0.0	0	0
38 S	317.7	0.0	232	143.7	317.7	74	74	58	143.7	232	33338	0.0	0	0	0	0.0	0	0
43 S	359.5	0.0	259	185.9	359.5	84	84	75	185.9	259	48148	0.0	0	0	0	0.0	0	0
48 S	401.3	0.0	292	166.1	102.7	24	24	6	14.9	292	4351	298.6	70	70	61	151.2	292	44150
53 S	443.1	0.0	343	180.9	144.5	34	34	12	29.7	343	10187	298.6	70	70	61	151.2	343	51862
58 S	484.9	0.0	381	200.8	186.3	44	44	20	49.6	381	18898	298.6	70	70	61	151.2	381	57607
63 S	526.7	0.0	388	223.1	228.1	53	53	29	71.9	388	27897	298.6	70	70	61	151.2	388	58666
68 S	568.5	0.0	374	255.3	269.9	63	63	42	104.1	374	38933	298.6	70	70	61	151.2	374	56549
73 S	610.3	0.0	357	290.0	311.7	73	73	56	138.8	357	49552	298.6	70	70	61	151.2	357	53978
78 S	652.1	0.0	308	332.1	353.5	83	83	73	180.9	308	55717	298.6	70	70	61	151.2	308	46570
83 S	693.9	0.0	247	354.4	331.3	78	78	65	161.1	247	39792	362.6	85	85	78	193.3	247	47745
88 S	735.7	0.0	171	384.1	309.1	72	72	55	136.3	171	23307	426.6	100	100	100	247.8	171	42374
93 S	777.5	0.0	109	423.7	350.9	82	82	71	175.9	109	19173	426.6	100	100	100	247.8	109	27010
98 S	819.3	0.0	59	470.8	392.7	92	92	90	223.0	59	13157	426.6	100	100	100	247.8	59	14620
103 S	861.1	29.2	25	485.7	405.3	95	95	96	237.9	25	5948	426.6	100	100	100	247.8	25	6195
108 S	902.9	71.0	7	485.7	405.3	95	95	96	237.9	7	1665	426.6	100	100	100	247.8	7	1735
113 S	944.7	112.8	2	485.7	405.3	95	95	96	237.9	2	476	426.6	100	100	100	247.8	2	498
118 S	986.5	154.6	0	485.7	405.3	95	95	96	237.9	0	0	426.6	100	100	100	247.8	0	0
			8602							4200	431518						3063	509557

APPENDIX J

Table J-1. ECO-2 Calculation of Chiller Energy Cost for New Conditions.

PLANT NO:	19		MASTER CHILLER NO (LEAD):	28	
BUILDING NO:	31008				
DESIGN LOAD:	458	TONS	COMPRESSOR:	SCREW	W/ TURBO
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-22	
			STATUS:	EXISTING	
PEAK DEMAND:	289.0	KW			
CONSUMPTION:	507623	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$44,101	/YR	LOAD LIMIT:	95	%
ENERGY COST:	$12,183	/YR			
TOTAL COST:	$56,284	/YR	RATED CAPACITY:	460.0	TONS
			RATED POWER:	301.0	KW
UNIT OUTPUT COST:	$129	/TON*YR	RATED EFFICIENCY:	0.654	KW/TON

% PLANT DSGN LOAD	PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%	TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
0 W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3 S	13.7	0.0	37	6.0	13.7	3	15	2	6.0	7	42
8 S	36.6	0.0	50	6.0	36.6	8	15	2	6.0	27	162
13 S	59.5	0.0	65	6.0	59.5	13	15	2	6.0	56	336
18 S	82.4	0.0	83	9.0	82.4	18	18	3	9.0	83	747
23 S	105.3	0.0	106	15.1	105.3	23	23	5	15.1	106	1601
28 S	128.2	0.0	143	24.1	128.2	28	28	8	24.1	143	3446
33 S	151.1	0.0	184	33.1	151.1	33	33	11	33.1	184	6090
38 S	174.0	0.0	232	45.2	174.0	38	38	15	45.2	232	10486
43 S	196.9	0.0	259	57.2	196.9	43	43	19	57.2	259	14815
48 S	219.8	0.0	292	72.2	219.8	48	48	24	72.2	292	21082
53 S	242.7	0.0	343	87.3	242.7	53	53	29	87.3	343	29944
58 S	265.6	0.0	381	105.4	265.6	58	58	35	105.4	381	40157
63 S	288.5	0.0	388	126.4	288.5	63	63	42	126.4	388	49043
68 S	311.4	0.0	374	147.5	311.4	68	68	49	147.5	374	55165
73 S	334.3	0.0	357	168.6	334.3	73	73	56	168.6	357	60190
78 S	357.2	0.0	308	195.7	357.2	78	78	65	195.7	308	60276
83 S	380.1	0.0	247	219.7	380.1	83	83	73	219.7	247	54266
88 S	403.0	0.0	171	249.8	403.0	88	88	83	249.8	171	42716
93 S	425.9	0.0	109	276.9	425.9	93	93	92	276.9	109	30182
98 S	448.8	11.8	59	289.0	437.0	95	95	96	289.0	59	17051
103 S	471.7	34.7	25	289.0	437.0	95	95	96	289.0	25	7225
108 S	494.6	57.6	7	289.0	437.0	95	95	96	289.0	7	2023
113 S	517.5	80.5	2	289.0	437.0	95	95	96	289.0	2	578
118 S	540.4	103.4	0	289.0	437.0	95	95	96	289.0	0	0
			8602							4160	507623

PLANT NO:	20		MASTER CHILLER NO (LEAD):	29	
BUILDING NO:	34008				
DESIGN LOAD:	485	TONS	COMPRESSOR:	SCREW	W/ TURBO
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-22	
			STATUS:	EXISTING	
PEAK DEMAND:	289.0	KW			
CONSUMPTION:	561689	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$44,101	/YR	LOAD LIMIT:	95	%
ENERGY COST:	$13,481	/YR			
TOTAL COST:	$57,582	/YR	RATED CAPACITY:	460.0	TONS
			RATED POWER:	301.0	KW
UNIT OUTPUT COST:	$132	/TON*YR	RATED EFFICIENCY:	0.654	KW/TON

% PLANT DSGN LOAD	PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%	TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
0 W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3 S	14.6	0.0	37	6.0	14.6	3	15	2	6.0	7	42
8 S	38.8	0.0	50	6.0	38.8	8	15	2	6.0	27	162
13 S	63.1	0.0	65	6.0	63.1	14	15	2	6.0	61	366
18 S	87.3	0.0	83	9.0	87.3	19	19	3	9.0	83	747
23 S	111.6	0.0	106	18.1	111.6	24	24	6	18.1	106	1919
28 S	135.8	0.0	143	27.1	135.8	30	30	9	27.1	143	3875
33 S	160.1	0.0	184	39.1	160.1	35	35	13	39.1	184	7194
38 S	184.3	0.0	232	51.2	184.3	40	40	17	51.2	232	11878
43 S	208.6	0.0	259	63.2	208.6	45	45	21	63.2	259	16369
48 S	232.8	0.0	292	81.3	232.8	51	51	27	81.3	292	23740
53 S	257.1	0.0	343	99.3	257.1	56	56	33	99.3	343	34060
58 S	281.3	0.0	381	117.4	281.3	61	61	39	117.4	381	44729
63 S	305.6	0.0	388	138.5	305.6	66	66	46	138.5	388	53738
68 S	329.8	0.0	374	165.6	329.8	72	72	55	165.6	374	61934
73 S	354.1	0.0	357	189.6	354.1	77	77	63	189.6	357	67687
78 S	378.3	0.0	308	213.7	378.3	82	82	71	213.7	308	65820
83 S	402.6	0.0	247	249.8	402.6	88	88	83	249.8	247	61701
88 S	426.8	0.0	171	276.9	426.8	93	93	92	276.9	171	47350
93 S	451.1	14.1	109	289.0	437.0	95	95	96	289.0	109	31501
98 S	475.3	38.3	59	289.0	437.0	95	95	96	289.0	59	17051
103 S	499.6	62.6	25	289.0	437.0	95	95	96	289.0	25	7225
108 S	523.8	86.8	7	289.0	437.0	95	95	96	289.0	7	2023
113 S	548.1	111.1	2	289.0	437.0	95	95	96	289.0	2	578
118 S	572.3	135.3	0	289.0	437.0	95	95	96	289.0	0	0
			8602							4165	561689

APPENDIX J

Table J-1. ECO-2 Calculation of Chiller Energy Cost for New Conditions.

PLANT NO:	21		MASTER CHILLER NO (LEAD):	31		MASTER CHILLER NO (LAG 1):	30	
BUILDING NO:	36000							
DESIGN LOAD:	1155	TONS	COMPRESSOR:	CENT	W/ TURBO	COMPRESSOR:	CENT	
WINTER LOAD:	20	%DSGN	CONDENSER:	WATER		CONDENSER:	WATER	
SIMULATION MODEL:	EQ-3		REFRIGERANT:	R-123		REFRIGERANT:	R-123	
			STATUS:	NEW		STATUS:	NEW	
PEAK DEMAND:	731.7	KW						
CONSUMPTION:	1644885	KWH/YR	CONFIGURATION:	PARALLEL		CONFIGURATION:	PARALLEL	
			MAX LEAD SETPT or PRO-RATE LOAD:	85	%	MIN LAG SETPOINT:	NA	%
DEMAND COST:	$111,657	/YR	LOAD LIMIT:	95	%	LOAD LIMIT:	100	%
ENERGY COST:	$39,477	/YR						
TOTAL COST:	$151,135	/YR	RATED CAPACITY:	425.7	TONS	RATED CAPACITY:	425.7	TONS
			RATED POWER:	247.2	KW	RATED POWER:	247.2	KW
UNIT OUTPUT COST:	$120	/TON*YR	RATED EFFICIENCY:	0.581	KW/TON	RATED EFFICIENCY:	0.581	KW/TON

% PLANT DSGN LOAD (%)	PLANT LOAD (TONS)	PLANT LOAD SHED (TONS)	ANNUAL OCCUR ACTUAL (HR/YR)	PLANT DEMAND (KW)	CHIL LOAD (TONS)	% RAT CAP ACT (%)	% RAT CAP ADJ (%)	% RAT POW (%)	POWER (KW)	ANNUAL OCCUR ADJUST (HR/YR)	ANNUAL ENERGY CONSUMP (KWH/YR)	CHIL LOAD (TONS)	% RAT CAP ACT (%)	% RAT CAP ADJ (%)	% RAT POW (%)	POWER (KW)	ANNUAL OCCUR ADJUST (HR/YR)	ANNUAL ENERGY CONSUMP (KWH/YR)
20 W	231.0	0.0	4380	74.2	231.0	54	54	30	74.2	4380	324998	0.0	0	0	0	0.0	0	0
3 S	34.7	0.0	37	4.9	34.7	8	15	2	4.9	20	98	0.0	0	0	0	0.0	0	0
8 S	92.4	0.0	50	12.4	92.4	22	22	5	12.4	50	620	0.0	0	0	0	0.0	0	0
13 S	150.2	0.0	65	32.1	150.2	35	35	13	32.1	65	2087	0.0	0	0	0	0.0	0	0
18 S	207.9	0.0	83	61.8	207.9	49	49	25	61.8	83	5129	0.0	0	0	0	0.0	0	0
23 S	265.7	0.0	106	101.4	265.7	62	62	41	101.4	106	10748	0.0	0	0	0	0.0	0	0
28 S	323.4	0.0	143	150.8	323.4	76	76	61	150.8	143	21564	0.0	0	0	0	0.0	0	0
33 S	381.2	0.0	184	143.3	185.7	44	44	20	49.4	184	9090	195.5	46	46	38	93.9	184	17278
38 S	438.9	0.0	232	173.1	213.8	50	50	26	64.3	232	14918	225.1	53	53	44	108.8	232	25242
43 S	496.7	0.0	259	210.1	242.0	57	57	34	84.0	259	21756	254.7	60	60	51	126.1	259	32660
48 S	554.4	0.0	292	247.2	270.1	63	63	42	103.8	292	30310	284.3	67	67	58	143.4	292	41873
53 S	612.2	0.0	343	289.2	298.3	70	70	52	128.5	343	44076	313.9	74	74	65	160.7	343	55120
58 S	669.9	0.0	381	338.6	326.4	77	77	63	155.7	381	59322	343.5	81	81	74	182.9	381	69685
63 S	727.7	0.0	388	318.8	234.3	55	55	31	76.6	388	29721	246.7	58	58	49	121.1	388	46987
68 S	785.4	0.0	374	356.0	252.9	59	59	36	89.0	374	33286	266.2	63	63	54	133.5	374	49929
73 S	843.2	0.0	357	393.1	271.5	64	64	43	106.3	357	37949	285.8	67	67	58	143.4	357	51194
78 S	900.9	0.0	308	432.5	290.1	68	68	49	121.1	308	37299	305.4	72	72	63	155.7	308	47958
83 S	958.7	0.0	247	474.6	308.7	73	73	56	138.4	247	34185	325.0	76	76	68	168.1	247	41521
88 S	1016.4	0.0	171	521.5	327.3	77	77	63	155.7	171	26625	344.5	81	81	74	182.9	171	31278
93 S	1074.2	0.0	109	568.6	345.9	81	81	70	173.0	109	18857	364.1	86	86	80	197.8	109	21560
98 S	1131.9	0.0	59	615.5	364.5	86	86	79	195.3	59	11523	383.7	90	90	85	210.1	59	12396
103 S	1189.7	0.0	25	669.9	383.1	90	90	87	215.1	25	5378	403.3	95	95	92	227.4	25	5685
108 S	1247.4	0.0	7	717.0	401.7	94	94	94	232.4	7	1627	422.8	99	99	98	242.3	7	1696
113 S	1305.2	49.4	2	731.7	404.4	95	95	96	237.3	2	475	425.7	100	100	100	247.2	2	494
118 S	1362.9	107.1	0	731.7	404.4	95	95	98	237.3	0	0	425.7	100	100	100	247.2	0	0
			8602							8585	781639						3738	552552

PLANT NO:	22		MASTER CHILLER NO (LEAD):	33	
BUILDING NO:	36006				
DESIGN LOAD:	259	TONS	COMPRESSOR:	CENT	W/ TURBO
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-123	
			STATUS:	NEW	
PEAK DEMAND:	180.0	KW			
CONSUMPTION:	280142	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$27,468	/YR	LOAD LIMIT:	95	%
ENERGY COST:	$6,723	/YR			
TOTAL COST:	$34,191	/YR	RATED CAPACITY:	275.0	TONS
			RATED POWER:	187.5	KW
UNIT OUTPUT COST:	$131	/TON*YR	RATED EFFICIENCY:	0.682	KW/TON

% PLANT DSGN LOAD (%)	PLANT LOAD (TONS)	PLANT LOAD SHED (TONS)	ANNUAL OCCUR ACTUAL (HR/YR)	PLANT DEMAND (KW)	CHIL LOAD (TONS)	% RAT CAP ACT (%)	% RAT CAP ADJ (%)	% RAT POW (%)	POWER (KW)	ANNUAL OCCUR ADJUST (HR/YR)	ANNUAL ENERGY CONSUMP (KWH/YR)
0 W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3 S	7.8	0.0	37	3.8	7.8	3	15	2	3.8	7	27
8 S	20.7	0.0	50	3.8	20.7	8	15	2	3.8	27	103
13 S	33.7	0.0	65	3.8	33.7	12	15	2	3.8	52	198
18 S	46.6	0.0	83	5.6	46.6	17	17	3	5.6	83	465
23 S	59.6	0.0	106	9.4	59.6	22	22	5	9.4	106	996
28 S	72.5	0.0	143	13.1	72.5	26	26	7	13.1	143	1873
33 S	85.5	0.0	184	18.8	85.5	31	31	10	18.8	184	3459
38 S	98.4	0.0	232	24.4	98.4	36	36	13	24.4	232	5661
43 S	111.4	0.0	259	31.9	111.4	41	41	17	31.9	259	8262
48 S	124.3	0.0	292	39.4	124.3	45	45	21	39.4	292	11505
53 S	137.3	0.0	343	48.8	137.3	50	50	26	48.8	343	16738
58 S	150.2	0.0	381	58.1	150.2	55	55	31	58.1	381	22136
63 S	163.2	0.0	388	67.5	163.2	59	59	36	67.5	388	26190
68 S	176.1	0.0	374	80.6	176.1	64	64	43	80.6	374	30144
73 S	189.1	0.0	357	93.8	189.1	69	69	50	93.8	357	33487
78 S	202.0	0.0	308	105.0	202.0	73	73	56	105.0	308	32340
83 S	215.0	0.0	247	121.9	215.0	78	78	65	121.9	247	30109
88 S	227.9	0.0	171	136.9	227.9	83	83	73	136.9	171	23410
93 S	240.9	0.0	109	155.6	240.9	88	88	83	155.6	109	16960
98 S	253.8	0.0	59	168.8	253.8	92	92	90	168.8	59	9959
103 S	266.8	5.5	25	180.0	261.3	95	95	96	180.0	25	4500
108 S	279.7	18.4	7	180.0	261.3	95	95	96	180.0	7	1260
113 S	292.7	31.4	2	180.0	261.3	95	95	96	180.0	2	360
118 S	305.6	44.3	0	180.0	261.3	95	95	96	180.0	0	0
			8602							4156	280142

APPENDIX J

Table J-1. ECO-2 Calculation of Chiller Energy Cost for New Conditions.

PLANT NO:	25		MASTER CHILLER NO (LEAD):	38		MASTER CHILLER NO (LAG 1):	37	
BUILDING NO:	39015							
DESIGN LOAD:	980	TONS	COMPRESSOR:	CENT	W/ TURBO	COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER		CONDENSER:	WATER	
SIMULATION MODEL:	EQ-2S		REFRIGERANT:	R-123		REFRIGERANT:	R-123	
			STATUS:	NEW		STATUS:	NEW	
PEAK DEMAND:	569.0	KW						
CONSUMPTION:	1122680	KWH/YR	CONFIGURATION:	SERIES/SINGLE		CONFIGURATION:	SERIES/SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	85	%	MIN LAG SETPOINT:	70	%
DEMAND COST:	$86,829	/YR	LOAD LIMIT:	95	%	LOAD LIMIT:	100	%
ENERGY COST:	$26,944	/YR						
TOTAL COST:	$113,774	/YR	RATED CAPACITY:	490.0	TONS	RATED CAPACITY:	490.0	TONS
			RATED POWER:	290.3	KW	RATED POWER:	290.3	KW
UNIT OUTPUT COST:	$119	/TON-YR	RATED EFFICIENCY:	0.592	KW/TON	RATED EFFICIENCY:	0.592	KW/TON

% PLANT DSGN LOAD	PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%	TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR	TONS	%	%	%	KW	HR/YR	KWH/YR
0 W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0	0.0	0	0	0	0.0	0	0
3 S	29.4	0.0	37	5.8	29.4	6	15	2	5.8	15	87	0.0	0	0	0	0.0	0	0
8 S	78.4	0.0	50	5.8	78.4	16	16	2	5.8	50	290	0.0	0	0	0	0.0	0	0
13 S	127.4	0.0	65	20.3	127.4	26	26	7	20.3	65	1320	0.0	0	0	0	0.0	0	0
18 S	176.4	0.0	83	37.7	176.4	36	36	13	37.7	83	3129	0.0	0	0	0	0.0	0	0
23 S	225.4	0.0	106	63.9	225.4	46	46	22	63.9	106	6773	0.0	0	0	0	0.0	0	0
28 S	274.4	0.0	143	95.8	274.4	56	56	33	95.8	143	13699	0.0	0	0	0	0.0	0	0
33 S	323.4	0.0	184	133.5	323.4	66	66	46	133.5	184	24564	0.0	0	0	0	0.0	0	0
38 S	372.4	0.0	232	177.1	372.4	76	76	61	177.1	232	41087	0.0	0	0	0	0.0	0	0
43 S	421.4	0.0	259	182.9	78.4	16	16	2	5.8	259	1502	343.0	70	70	61	177.1	259	45869
48 S	470.4	0.0	292	197.4	127.4	26	26	7	20.3	292	5928	343.0	70	70	61	177.1	292	51713
53 S	519.4	0.0	343	214.8	176.4	36	36	13	37.7	343	12931	343.0	70	70	61	177.1	343	60745
58 S	568.4	0.0	381	241.0	225.4	46	46	22	63.9	381	24346	343.0	70	70	61	177.1	381	67475
63 S	617.4	0.0	388	272.9	274.4	56	56	33	95.8	388	37170	343.0	70	70	61	177.1	388	68715
68 S	666.4	0.0	374	310.6	323.4	66	66	46	133.5	374	49929	343.0	70	70	61	177.1	374	66235
73 S	715.4	0.0	357	354.2	372.4	76	76	61	177.1	357	63225	343.0	70	70	61	177.1	357	63225
78 S	764.4	0.0	308	380.3	347.9	71	71	53	153.9	308	47401	416.5	85	85	78	226.4	308	69731
83 S	813.4	0.0	247	429.6	396.9	81	81	70	203.2	247	50190	416.5	85	85	78	226.4	247	55921
88 S	862.4	0.0	171	467.4	372.4	76	76	61	177.1	171	30284	490.0	100	100	100	290.3	171	49641
93 S	911.4	0.0	109	519.6	421.4	86	86	79	229.3	109	24994	490.0	100	100	100	290.3	109	31643
98 S	960.4	4.9	59	569.0	465.5	95	95	96	278.7	59	16443	490.0	100	100	100	290.3	59	17128
103 S	1009.4	53.9	25	569.0	465.5	95	95	96	278.7	25	6968	490.0	100	100	100	290.3	25	7258
108 S	1058.4	102.9	7	569.0	465.5	95	95	96	278.7	7	1951	490.0	100	100	100	290.3	7	2032
113 S	1107.4	151.9	2	569.0	465.5	95	95	96	278.7	2	557	490.0	100	100	100	290.3	2	581
118 S	1156.4	200.9	0	569.0	465.5	95	95	96	278.7	0	0	490.0	100	100	100	290.3	0	0
			8602							4200	464768						3322	657912

PLANT NO:	26		MASTER CHILLER NO (LEAD):	40		MASTER CHILLER NO (LAG 1):	39	
BUILDING NO:	39043							
DESIGN LOAD:	1084	TONS	COMPRESSOR:	CENT	W/ TURBO	COMPRESSOR:	CENT	
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER		CONDENSER:	WATER	
SIMULATION MODEL:	EQ-2S		REFRIGERANT:	R-123		REFRIGERANT:	R-123	
			STATUS:	NEW		STATUS:	NEW	
PEAK DEMAND:	674.6	KW						
CONSUMPTION:	1282336	KWH/YR	CONFIGURATION:	SERIES/SINGLE		CONFIGURATION:	SERIES/SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	85	%	MIN LAG SETPOINT:	70	%
DEMAND COST:	$102,944	/YR	LOAD LIMIT:	95	%	LOAD LIMIT:	100	%
ENERGY COST:	$30,776	/YR						
TOTAL COST:	$133,720	/YR	RATED CAPACITY:	560.0	TONS	RATED CAPACITY:	560.0	TONS
			RATED POWER:	344.2	KW	RATED POWER:	344.2	KW
UNIT OUTPUT COST:	$122	/TON-YR	RATED EFFICIENCY:	0.615	KW/TON	RATED EFFICIENCY:	0.615	KW/TON

% PLANT DSGN LOAD	PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%	TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR	TONS	%	%	%	KW	HR/YR	KWH/YR
0 W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0	0.0	0	0	0	0.0	0	0
3 S	32.5	0.0	37	6.9	32.5	6	15	2	6.9	15	104	0.0	0	0	0	0.0	0	0
8 S	86.7	0.0	50	6.9	86.7	15	15	2	6.9	50	345	0.0	0	0	0	0.0	0	0
13 S	140.9	0.0	65	20.7	140.9	25	25	6	20.7	65	1346	0.0	0	0	0	0.0	0	0
18 S	195.1	0.0	83	44.7	195.1	35	35	13	44.7	83	3710	0.0	0	0	0	0.0	0	0
23 S	249.3	0.0	106	72.3	249.3	45	45	21	72.3	106	7664	0.0	0	0	0	0.0	0	0
28 S	303.5	0.0	143	103.3	303.5	54	54	30	103.3	143	14772	0.0	0	0	0	0.0	0	0
33 S	357.7	0.0	184	148.0	357.7	64	64	43	148.0	184	27232	0.0	0	0	0	0.0	0	0
38 S	411.9	0.0	232	199.6	411.9	74	74	58	199.6	232	46307	0.0	0	0	0	0.0	0	0
43 S	466.1	0.0	259	251.3	466.1	83	83	73	251.3	259	65087	0.0	0	0	0	0.0	0	0
48 S	520.3	0.0	292	227.2	128.3	23	23	5	17.2	292	5022	392.0	70	70	61	210.0	292	61320
53 S	574.5	0.0	343	247.9	182.5	33	33	11	37.9	343	13000	392.0	70	70	61	210.0	343	72030
58 S	628.7	0.0	381	272.0	236.7	42	42	18	62.0	381	23622	392.0	70	70	61	210.0	381	80010
63 S	682.9	0.0	388	306.4	290.9	52	52	28	96.4	388	37403	392.0	70	70	61	210.0	388	81480
68 S	737.1	0.0	374	351.1	345.1	62	62	41	141.1	374	52771	392.0	70	70	61	210.0	374	78540
73 S	791.3	0.0	357	392.4	399.3	71	71	53	182.4	357	65117	392.0	70	70	61	210.0	357	74970
78 S	845.5	0.0	308	450.9	453.5	81	81	70	240.9	308	74197	392.0	70	70	61	210.0	308	64680
83 S	899.7	0.0	247	478.5	423.7	76	76	61	210.0	247	51870	476.0	85	85	78	268.5	247	66320
88 S	953.9	0.0	171	523.2	393.9	70	70	52	179.0	171	30609	560.0	100	100	100	344.2	171	58858
93 S	1008.1	0.0	109	578.3	448.1	80	80	68	234.1	109	25517	560.0	100	100	100	344.2	109	37518
98 S	1062.3	0.0	59	643.7	502.3	90	90	87	299.5	59	17671	560.0	100	100	100	344.2	59	20308
103 S	1116.5	24.5	25	674.6	532.0	95	95	96	330.4	25	8260	560.0	100	100	100	344.2	25	8605
108 S	1170.7	78.7	7	674.6	532.0	95	95	96	330.4	7	2313	560.0	100	100	100	344.2	7	2409
113 S	1224.9	132.9	2	674.6	532.0	95	95	96	330.4	2	661	560.0	100	100	100	344.2	2	688
118 S	1279.1	187.1	0	674.6	532.0	95	95	96	330.4	0	0	560.0	100	100	100	344.2	0	0
			8602							4200	574600						3063	707736

APPENDIX J

Table J-1. ECO-2 Calculation of Chiller Energy Cost for New Conditions.

PLANT NO:	27		MASTER CHILLER NO (LEAD):	41	
BUILDING NO:	41003				
DESIGN LOAD:	232	TONS	COMPRESSOR:	CENT	W/ TURBO
WINTER LOAD:	0	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-123	
			STATUS:	NEW	
PEAK DEMAND:	151.1	KW			
CONSUMPTION:	275440	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$23,058	/YR	LOAD LIMIT:	95	%
ENERGY COST:	$6,611	/YR			
TOTAL COST:	$29,668	/YR	RATED CAPACITY:	227.5	TONS
			RATED POWER:	157.4	KW
UNIT OUTPUT COST:	$137	/TON*YR	RATED EFFICIENCY:	0.692	KW/TON

% PLANT DSGN LOAD	PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%	TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
0 W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3 S	7.0	0.0	37	3.1	7.0	3	15	2	3.1	7	22
8 S	18.6	0.0	50	3.1	18.6	8	15	2	3.1	27	84
13 S	30.2	0.0	65	3.1	30.2	13	15	2	3.1	56	174
18 S	41.8	0.0	83	4.7	41.8	18	18	3	4.7	83	390
23 S	53.4	0.0	106	7.9	53.4	23	23	5	7.9	106	837
28 S	65.0	0.0	143	14.2	65.0	29	29	9	14.2	143	2031
33 S	76.6	0.0	184	18.9	76.6	34	34	12	18.9	184	3478
38 S	88.2	0.0	232	25.2	88.2	39	39	16	25.2	232	5846
43 S	99.8	0.0	259	31.5	99.8	44	44	20	31.5	259	8159
48 S	111.4	0.0	292	39.4	111.4	49	49	25	39.4	292	11505
53 S	123.0	0.0	343	47.2	123.0	54	54	30	47.2	343	16190
58 S	134.6	0.0	381	56.7	134.6	59	59	36	56.7	381	21603
63 S	146.2	0.0	388	67.7	146.2	64	64	43	67.7	388	26268
68 S	157.8	0.0	374	78.7	157.8	69	69	50	78.7	374	29434
73 S	169.4	0.0	357	91.3	169.4	74	74	58	91.3	357	32594
78 S	181.0	0.0	308	107.0	181.0	80	80	68	107.0	308	32956
83 S	192.6	0.0	247	121.2	192.6	85	85	77	121.2	247	29936
88 S	204.2	0.0	171	136.9	204.2	90	90	87	136.9	171	23410
93 S	215.8	0.0	109	151.1	215.8	95	95	96	151.1	109	16470
98 S	227.4	11.3	59	151.1	216.1	95	95	96	151.1	59	8915
103 S	239.0	22.9	25	151.1	216.1	95	95	96	151.1	25	3778
108 S	250.6	34.5	7	151.1	216.1	95	95	96	151.1	7	1058
113 S	262.2	46.1	2	151.1	216.1	95	95	96	151.1	2	302
118 S	273.8	57.7	0	151.1	216.1	95	95	96	151.1	0	0
			8602							4160	275440

PLANT NO:	30		MASTER CHILLER NO (LEAD):	44	
BUILDING NO:	50004				
DESIGN LOAD:	306	TONS	COMPRESSOR:	CENT	W/ TURBO
WINTER LOAD:	20	%DSGN	CONDENSER:	WATER	
SIMULATION MODEL:	EQ-1		REFRIGERANT:	R-123	
			STATUS:	NEW	
PEAK DEMAND:	190.1	KW			
CONSUMPTION:	368478	KWH/YR	CONFIGURATION:	SINGLE	
			MAX LEAD SETPT or PRO-RATE LOAD:	NA	%
DEMAND COST:	$29,009	/YR	LOAD LIMIT:	95	%
ENERGY COST:	$8,843	/YR			
TOTAL COST:	$37,853	/YR	RATED CAPACITY:	306.0	TONS
			RATED POWER:	198.0	KW
UNIT OUTPUT COST:	$130	/TON*YR	RATED EFFICIENCY:	0.647	KW/TON

% PLANT DSGN LOAD	PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%	TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
20 W	61.2	0.0	4380	7.9	61.2	20	20	4	7.9	4380	34602
3 S	9.2	0.0	37	4.0	9.2	3	15	2	4.0	7	28
8 S	24.5	0.0	50	4.0	24.5	8	15	2	4.0	27	108
13 S	39.8	0.0	65	4.0	39.8	13	15	2	4.0	56	224
18 S	55.1	0.0	83	5.9	55.1	18	18	3	5.9	83	490
23 S	70.4	0.0	106	9.9	70.4	23	23	5	9.9	106	1049
28 S	85.7	0.0	143	15.8	85.7	28	28	8	15.8	143	2259
33 S	101.0	0.0	184	21.8	101.0	33	33	11	21.8	184	4011
38 S	116.3	0.0	232	29.7	116.3	38	38	15	29.7	232	6890
43 S	131.6	0.0	259	37.6	131.6	43	43	19	37.6	259	9738
48 S	146.9	0.0	292	47.5	146.9	48	48	24	47.5	292	13870
53 S	162.2	0.0	343	57.4	162.2	53	53	29	57.4	343	19688
58 S	177.5	0.0	381	69.3	177.5	58	58	35	69.3	381	26403
63 S	192.8	0.0	388	83.2	192.8	63	63	42	83.2	388	32282
68 S	208.1	0.0	374	97.0	208.1	68	68	49	97.0	374	36278
73 S	223.4	0.0	357	110.9	223.4	73	73	56	110.9	357	39591
78 S	238.7	0.0	308	128.7	238.7	78	78	65	128.7	308	39640
83 S	254.0	0.0	247	144.5	254.0	83	83	73	144.5	247	35692
88 S	269.3	0.0	171	164.3	269.3	88	88	83	164.3	171	28095
93 S	284.6	0.0	109	182.2	284.6	93	93	92	182.2	109	19860
98 S	299.9	9.2	59	190.1	290.7	95	95	96	190.1	59	11216
103 S	315.2	24.5	25	190.1	290.7	95	95	96	190.1	25	4753
108 S	330.5	39.8	7	190.1	290.7	95	95	96	190.1	7	1331
113 S	345.8	55.1	2	190.1	290.7	95	95	96	190.1	2	380
118 S	361.1	70.4	0	190.1	290.7	95	95	96	190.1	0	0
			8602							8540	368478

APPENDIX J

Table J-1. ECO-2 Calculation of Chiller Energy Cost for New Conditions.

PLANT NO:	31	
BUILDING NO:	87018	
DESIGN LOAD:	902	TONS
WINTER LOAD:	0	%DSGN
SIMULATION MODEL:	EQ-2S	
PEAK DEMAND:	548.0	KW
CONSUMPTION:	1011576	KWH/YR
DEMAND COST:	$83,625	/YR
ENERGY COST:	$24,278	/YR
TOTAL COST:	$107,903	/YR
UNIT OUTPUT COST:	$117	/TON*YR

MASTER CHILLER NO (LEAD):	48	
COMPRESSOR:	CENT	W/ TURBO
CONDENSER:	WATER	
REFRIGERANT:	R-123	
STATUS:	NEW	
CONFIGURATION:	SERIES/SINGLE	
MAX LEAD SETPT or PRO-RATE LOAD:	85	%
LOAD LIMIT:	95	%
RATED CAPACITY:	474.0	TONS
RATED POWER:	279.6	KW
RATED EFFICIENCY:	0.590	KW/TON

MASTER CHILLER NO (LAG 1):	47	
COMPRESSOR:	CENT	
CONDENSER:	WATER	
REFRIGERANT:	R-123	
STATUS:	NEW	
CONFIGURATION:	SERIES/SINGLE	
MIN LAG SETPOINT:	70	%
LOAD LIMIT:	100	%
RATED CAPACITY:	474.0	TONS
RATED POWER:	279.6	KW
RATED EFFICIENCY:	0.590	KW/TON

% PLANT DSGN LOAD	PLANT LOAD	PLANT LOAD SHED	ANNUAL OCCUR ACTUAL	PLANT DEMAND	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%	TONS	TONS	HR/YR	KW	TONS	%	%	%	KW	HR/YR	KWH/YR
0 W	0.0	0.0	4380	0.0	0.0	0	0	0	0.0	0	0
3 S	27.1	0.0	37	5.6	27.1	8	15	2	5.6	15	84
8 S	72.2	0.0	50	5.6	72.2	15	15	2	5.6	50	280
13 S	117.3	0.0	65	16.8	117.3	25	25	6	16.8	65	1092
18 S	162.4	0.0	83	33.6	162.4	34	34	12	33.6	83	2789
23 S	207.5	0.0	106	55.9	207.5	44	44	20	55.9	106	5925
28 S	252.6	0.0	143	81.1	252.6	53	53	29	81.1	143	11597
33 S	297.7	0.0	184	117.4	297.7	63	63	42	117.4	184	21602
38 S	342.8	0.0	232	153.8	342.8	72	72	55	153.8	232	35682
43 S	387.9	0.0	259	198.5	387.9	82	82	71	198.5	259	51412
48 S	433.0	0.0	292	181.8	101.2	21	21	4	11.2	292	3270
53 S	478.1	0.0	343	198.6	146.3	31	31	10	28.0	343	9604
58 S	523.2	0.0	381	218.1	191.4	40	40	17	47.5	381	18098
63 S	568.3	0.0	388	243.3	236.5	50	50	26	72.7	388	28208
68 S	613.4	0.0	374	271.3	281.6	59	59	36	100.7	374	37662
73 S	658.5	0.0	357	310.4	326.7	69	69	50	139.8	357	49909
78 S	703.6	0.0	308	352.3	371.8	78	78	65	181.7	308	55964
83 S	748.7	0.0	247	374.7	345.8	73	73	58	156.6	247	38680
88 S	793.8	0.0	171	416.6	390.9	82	82	71	198.5	171	33944
93 S	838.9	0.0	109	455.7	364.9	77	77	63	176.1	109	19195
98 S	884.0	0.0	59	500.5	410.0	86	86	79	220.9	59	13033
103 S	929.1	4.8	25	548.0	450.3	95	95	96	268.4	25	6710
108 S	974.2	49.9	7	548.0	450.3	95	95	96	268.4	7	1879
113 S	1019.3	95.0	2	548.0	450.3	95	95	96	268.4	2	537
118 S	1064.4	140.1	0	548.0	450.3	95	95	96	268.4	0	0
			8602							4200	447156

% PLANT DSGN LOAD	CHIL LOAD	% RAT CAP ACT	% RAT CAP ADJ	% RAT POW	POWER	ANNUAL OCCUR ADJUST	ANNUAL ENERGY CONSUMP
%	TONS	%	%	%	KW	HR/YR	KWH/YR
0 W	0.0	0	0	0	0.0	0	0
3 S	0.0	0	0	0	0.0	0	0
8 S	0.0	0	0	0	0.0	0	0
13 S	0.0	0	0	0	0.0	0	0
18 S	0.0	0	0	0	0.0	0	0
23 S	0.0	0	0	0	0.0	0	0
28 S	0.0	0	0	0	0.0	0	0
33 S	0.0	0	0	0	0.0	0	0
38 S	0.0	0	0	0	0.0	0	0
43 S	0.0	0	0	0	0.0	0	0
48 S	331.8	70	70	61	170.6	292	49815
53 S	331.8	70	70	61	170.6	343	58516
58 S	331.8	70	70	61	170.6	381	64999
63 S	331.8	70	70	61	170.6	388	66193
68 S	331.8	70	70	61	170.6	374	63804
73 S	331.8	70	70	61	170.6	357	60904
78 S	331.8	70	70	61	170.6	308	52545
83 S	402.9	85	85	78	218.1	247	53871
88 S	402.9	85	85	78	218.1	171	37295
93 S	474.0	100	100	100	279.6	109	30476
98 S	474.0	100	100	100	279.6	59	16496
103 S	474.0	100	100	100	279.6	25	6990
108 S	474.0	100	100	100	279.6	7	1957
113 S	474.0	100	100	100	279.6	2	559
118 S	474.0	100	100	100	279.6	0	0
						3063	564420

APPENDIX J

Table J-2. ECO-2 Summary of Chiller Energy Cost of New Conditions.

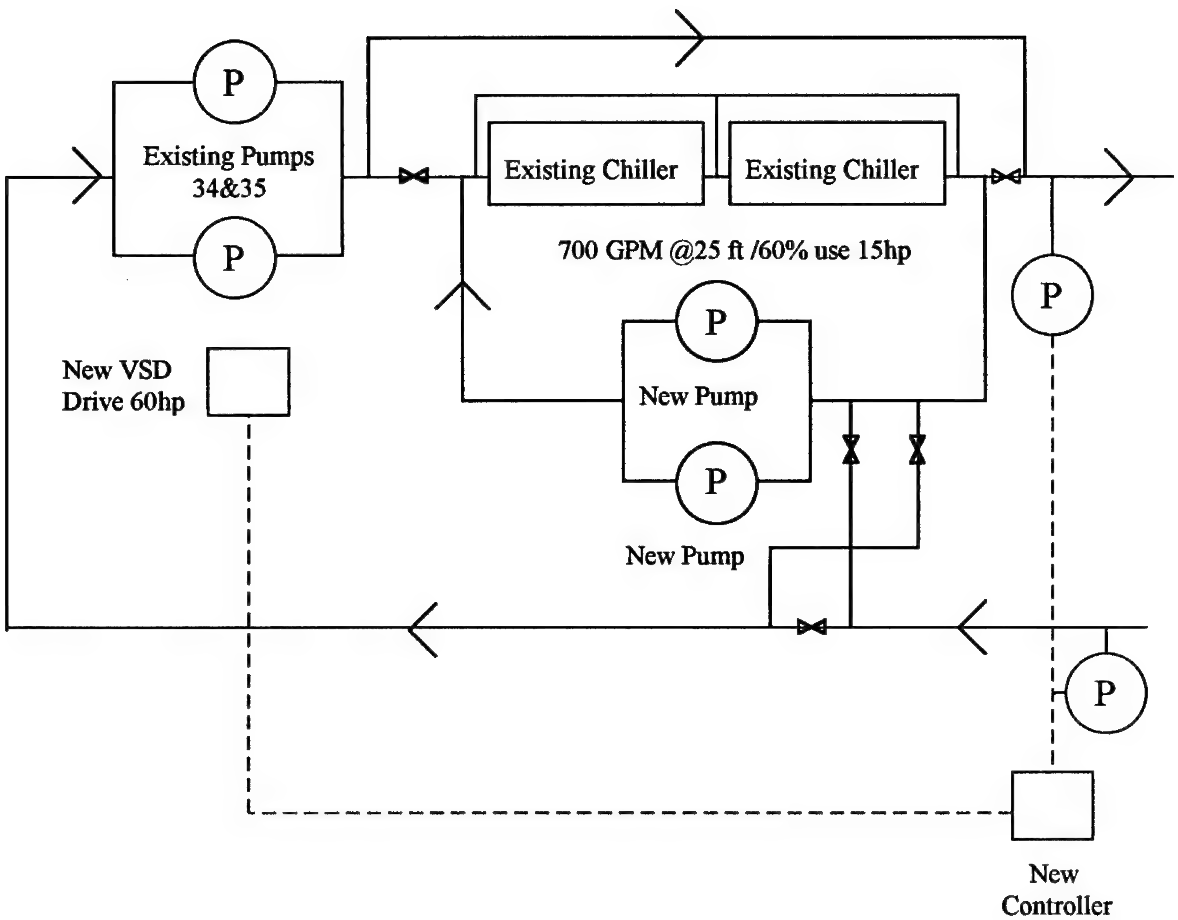
PLANT NO	PLANT BLDG NO	PLANT HAP CALC LOAD	OPER SCHED	PLANT NEW CAP	PLANT NEW/ EXIST CAP	PLANT w/ TURB MAX OUTPUT	PLANT w/ TURB PEAK DEMAND	PLANT w/ TURB CONSUMP	PLANT w/ TURB ENERGY COST	PLANT w/ TURB UNIT OUTPUT COST
		TONS	HR/YR	TONS	%	TONS	KW	KWH/YR	$/YR	$/TON*YR
1	121	138	4380	138.0	69	-	-	-	-	-
2	135	91	4380	91.0	71	-	-	-	-	-
3	194	107	4380	107.0	47	-	-	-	-	-
5	410	238	4380	238.0	108	232.1	160.5	316414	32086	138
6	2805	116	4380	116.0	77	-	-	-	-	-
7	5764	201	4380	201.0	81	191.0	131.3	230672	25573	134
8	5792	176	4380	170.0	100	-	-	-	-	-
9	7050	306	8760	306.0	73	298.4	196.6	426890	40247	135
10	7051	158	8760	158.0 +	93	-	-	-	-	-
13	14020	154	4380	154.0	110	-	-	-	-	-
14	14023	166	4380	166.0	114	-	-	-	-	-
15	21002	240	4380	240.0	112	228.0	162.6	285667	31669	139
16	27004	486	4380	465.0	100	441.8	262.7	501083	52114	118
17	28000	238	4380	238.0	108	-	-	-	-	-
18	29005	836	4380	853.2	90	831.9	485.7	941073	96704	116
19	31008	458	4380	460.0	SAME	437.0	289.0	507623	56284	129
20	34008	485	4380	460.0	SAME	437.0	289.0	561689	57582	132
21	36000	1155	8760	1277.1	100	1255.8	731.7	1644885	151135	120
22	36006	259	4380	275.0	100	261.3	180.0	280142	34191	131
23	36009	110	4380	95.5	SAME	-	-	-	-	-
24	36014	96	8760	96.2	100	-	-	-	-	-
25	39015	980	4380	980.0	81	955.5	569.0	1122680	113774	119
26	39043	1084	4380	1120.0	100	1092.0	674.6	1282336	133720	122
27	41003	232	4380	227.5	100	216.1	151.1	275440	29668	137
28	42000	189	4380	188.1	90	-	-	-	-	-
29	50001	129	8760	129.2	100	-	-	-	-	-
30	50004	306	8760	306.0	82	290.7	190.1	368478	37853	130
31	87018	902	4380	948.0	100	924.3	548.0	1011576	107903	117
32	91001	123	4380	121.8	100	-	-	-	-	-
		10159		10325.6	93					

APPENDIX J

Table J-3. ECO-2 Calculation of Simple Payback Periods.

PLANT NO	PLANT BLDG NO	PLANT HAP CALC LOAD TONS	OPER SCHED HR/YR	PLANT EXIST CAP TONS	PLANT NEW CAP TONS	PLANT NEW/EXIST CAP %	PLANT w/ TURB PEAK DEMAND SAVED KW/YR	%	PLANT w/ TURB CONSUMP SAVED KWH/YR	%	PLANT w/ TURB ENERGY COST SAVED $/YR	%	ADD CHILLER SPD CTRL COST $	PAYBK YRS
1	121	138	4380	200.0	138.0	69	-	-	-	-	-	-	-	-
2	135	91	4380	128.4	91.0	71	-	-	-	-	-	-	-	-
3	194	107	4380	228.0	107.0	47	-	-	-	-	-	-	-	-
5	410	238	4380	220.0	238.0	108	-16.3	-11	33529	10	-1682	-6	TOO SMALL	-
6	2805	116	4380	149.8	116.0	77	-	-	-	-	-	-	-	-
7	5764	201	4380	249.6	201.0	81	5.5	4	62612	21	2341	8	30250	12.9
8	5792	176	4380	170.0	170.0	100	-	-	-	-	-	-	-	-
9	7050	306	8760	420.0	306.0	73	4.0	2	118013	22	3442	8	TOO SMALL	-
10	7051	158	8760	170.0	158.0	93	-	-	-	-	-	-	TOO SMALL	-
13	14020	154	4380	140.4	154.0	110	-	-	-	-	-	-	-	-
14	14023	166	4380	146.0	166.0	114	-	-	-	-	-	-	-	-
15	21002	240	4380	215.0	240.0	112	-18.6	-13	74721	21	-1045	-3	34490	11.9
16	27004	486	4380	465.0	465.0	100	10.9	4	119183	19	4524	8	48247	10.7
17	28000	238	4380	220.0	238.0	108	-	-	-	-	-	-	TOO SMALL	-
18	29005	836	4380	948.0	853.2	90	9.9	2	114860	11	4267	4	44208	10.4
19	31008	458	4380	460.0	460.0	SAME	12.0	4	137597	21	5134	8	81557	15.9
20	34008	485	4380	460.0	460.0	SAME	12.0	4	126495	18	4867	8	81557	16.8
21	36000	1155	8760	1277.0	1277.1	100	9.9	1	272989	14	8062	5	44224	5.5
22	36006	259	4380	275.0	275.0	100	7.5	4	95246	25	3431	9	34259	10.0
23	36009	110	4380	95.5	95.5	SAME	-	-	-	-	-	-	-	-
24	36014	96	8760	96.2	96.2	100	-	-	-	-	-	-	-	-
25	39015	980	4380	1215.0	980.0	81	11.6	2	145628	11	5265	4	47879	9.1
26	39043	1084	4380	1120.0	1120.0	100	13.8	2	165216	11	6071	4	46660	7.7
27	41003	232	4380	227.5	227.5	100	6.3	4	69969	20	2641	8	29979	11.4
28	42000	189	4380	209.0	188.1	90	-	-	-	-	-	-	-	-
29	50001	129	8760	129.2	129.2	100	-	-	-	-	-	-	TOO SMALL	-
30	50004	306	8760	375.0	306.0	82	7.9	4	206324	36	6157	14	34114	5.5
31	87018	902	4380	948.0	948.0	100	11.2	2	137255	12	5003	4	48112	9.6
32	91001	123	4380	121.8	121.8	100	-	-	-	-	-	-	-	-
		10159		11079.4	10325.6	93	87.6		1879637		58478		605536	

Appendix K: ECO-3 (Install Variable Speed Drives for Pumps)



Try building 39015 for primary/secondary variable speed pumping.

Base Case Energy Consumption.

Original design flow 1696 GPM @ 16 degrees delta T

Measured flow 1312 GPM @ 191 ft efficiency=73%
BHP=43.2*2

New design flow 980T @ 16∠ δT=1470 GPM
$(1470/1312)^2$=delta P/191 therefore delta P=240 ft
Existing chilled water pressure drop=7 + 9=16 ft
Pumps 34 and 35 Aurora 60 HP 1770 RPM
use 700 GPM each @ 217 ft (max impeller)
$(1400/1312)^3$=BHP/43.2 } bhp=52.5 * 2=105
kW=105 BHP *0.7457/0.954 (high efficiency motor)=82.1 @ $152.60= $12,524/yr
kWh=82.1 kW * 4380=359598 @ $0.0240=$8,630/yr
Total cost=$21,154/yr

Energy Consumption With Variable Speed Drive.

Same as if Variable Speed Drive is limited to 95% load=$12,524/yr
Use 57% Average % full load per Appendix F
Neglect base load of primary pumps (benefit to ECO)
Neglect inefficiency loss of variable speed drive (benefit to ECO)
BHP=$(0.57)^3$ * 105=19.4
kW_{avg}=19.4 BHP * 0.7457/0.954=15.2
kWh=15.2 kW * 4380 @ $0.024=$1,598/yr
Total cost=$14,122/yr
Target $7,032/yr saved * 10 yrs = $70,000 capital cost

Variable Speed Drive Construction Cost.

60 hp VSD
Motor connection
wire 4-#2 @ 100 ft
conduit 1.1/4" @25 ft
controls 2 pressure sensors
1 output
test
Primary pump 700 gal 15 hp (2 of these)
(similar to building 50004 and 12015)
8" pipe @ 100 ft
8" elbow (24)

8" insulation @ 100 ft
8" valve (4)

Flow/Fill/Test
1400 gpm out/ 20 building ⁻ 70 gpm/building

Use	5 - 2 in	485 * 1.5
	15 - 11/2 in	370 * 1.5
	20 Sensor + Panel @ 750	
70%	20 Electrical * $6 * $45/hr	
70%	Extra Pipe Labor * $8 * $45/hr	

Material	Totals
$10,162*1.1	$11,178
	$14
	$107
	$72
	$2,500
$6,800*2	$13,600
	$3,080
	$2,033
	$310
	$946
	$33,840

Labor	Totals
100 hp Starter	$359
	$57
	$54
	$91
	$500
$5,200*2	$10,400
	$2,513
	$4,331
	$485
	$600
	$3,000
	$194
	$338
	$22,922

$22,922
<u>$33,840</u>
$56,762
<u>+15%</u>
$65,276 in Plant

$3,638
$8,325
$15,000
$3,780
<u>$5,040</u>
$35,783
<u>+15%</u>
$41,150

$41,150/20 = $2,000/Building

$106,426/7000 = 15 yr and climbing

Appendix L: ECO-4 (Replace Fan and Pump Motors)

APPENDIX L

Table L-1. ECO-4 Calculation of Simple Payback Periods for Chilled Water Pumps

PLANT NO	PLANT BLDG NO	MST CH NO	MST PMP NO	OPER SCHED	DSGN POW	PUMP STATUS	NEW 100% EFF	DELTA EFF	STD MIN EFF	MOTOR UTIL REBATE	MOTOR LIST PRICE	DISCONN/ CONNECT LAB COST	REMOVE/ INSTALL LAB COST	MOTOR TOTAL COST	POW COST EXIST	POW COST NEW	MOTOR COST SAVING	MOTOR PAYBK W/ REB
				HR/YR	HP		%	%	%	$	$	$	$	$	$/YR	$/YR	$/YR	YRS
1	121	1	1	4380	10	OK	91.7	CAN'T	85.5	79	633	60	181	1010	CAN'T	CAN'T	CAN'T	CAN'T
2	135	2	2	4380	5	OK	90.0	4.5	82.5	48	370	60	115	628	CAN'T	CAN'T	CAN'T	CAN'T
	135	3	3	4380	5	OK	90.0	CAN'T	82.5	48	370	60	115	628	CAN'T	CAN'T	CAN'T	CAN'T
3	194	4	4	4380	25	OK	94.0	CAN'T	89.5	150	1226	81	312	1875	CAN'T	3373	CAN'T	CAN'T
5	410	6	5	4380	7.5	OK	92.0	8.0	84.0	73	538	60	145	859	1030	940	90	8.7
	410	7	6	4380	7.5	OK	92.0	8.0	84.0	73	538	60	145	859	984	898	86	9.1
6	2805	8	7	4380	15	OK	93.0	CAN'T	88.0	98	864	81	218	1345	CAN'T	1695	CAN'T	CAN'T
7	5764	9	8	4380	15	OK	93.0	3.5	88.0	98	864	81	218	1345	CAN'T	CAN'T	CAN'T	CAN'T
8	5792	11	9	4380	20	OK	93.6	CAN'T	88.5	132	1005	81	292	1593	CAN'T	2361	CAN'T	CAN'T
9	7050	12	10	8760	25	OK	93.0	6.5	89.5	128	1212	81	312	1858	6068	5644	424	4.1
	7050	13	11	8760	25	OK	93.0	6.5	89.5	128	1212	81	312	1858	6068	5644	424	4.1
10	7051	14	12	8760	15	OK	93.0	7.0	88.0	98	864	81	218	1345	2800	2589	211	5.9
	7051	15	13	0	15	BACKUP	-	-	-	-	-	-	-	-	-	-	-	-
13	14020	20	14	4380	10	OK	91.7	6.1	85.5	79	633	60	181	1010	1706	1593	113	8.2
14	14023	21	15	4380	10	OK	91.7	4.7	85.5	79	633	60	181	1010	1767	1677	90	10.3
15	21002	22	16	4380	20	OK	93.6	CAN'T	88.5	132	1005	81	292	1593	CAN'T	2792	CAN'T	CAN'T
16	27004	23	17	4380	15	OK	92.4	CAN'T	88.0	91	887	81	218	1373	CAN'T	CAN'T	CAN'T	CAN'T
	27004		18	4380	15	OK	92.4	CAN'T	88.0	91	887	81	218	1373	CAN'T	CAN'T	CAN'T	CAN'T
17	28000	24	19	4380	7.5	OK	92.0	3.5	84.0	73	538	60	145	859	1281	1232	49	16.0
	28000	25	20	4380	7.5	OK	92.0	6.5	84.0	73	538	60	145	859	1214	1128	86	9.1
18	29005	26	21	4380	60	OK	95.4	CAN'T	91.5	320	2532	133	514	3691	CAN'T	6688	CAN'T	CAN'T
	29005	27	22	4380	60	OK	95.4	4.4	91.5	320	2532	133	514	3691	7011	6688	323	10.4
19	31008	28	23	4380	25	OK	94.0	4.8	89.5	150	1226	81	312	1875	CAN'T	CAN'T	CAN'T	CAN'T
	31008		24	4380	25	OK	94.0	4.8	89.5	150	1226	81	312	1875	CAN'T	CAN'T	CAN'T	CAN'T
20	34008	29	25	4380	25	OK	94.0	4.5	89.5	150	1226	81	312	1875	CAN'T	CAN'T	CAN'T	CAN'T
	34008		26	4380	25	OK	94.0	4.5	89.5	150	1226	81	312	1875	CAN'T	CAN'T	CAN'T	CAN'T
21	36000	30	27	8760	50	OK	95.0	CAN'T	91.5	250	2066	104	486	3080	CAN'T	CAN'T	CAN'T	CAN'T
	36000	31	28	8760	50	OK	95.0	CAN'T	91.5	250	2066	104	486	3080	CAN'T	CAN'T	CAN'T	CAN'T
	36000	32	29	8760	60	OK	95.4	3.0	91.5	320	2532	133	514	3691	CAN'T	CAN'T	CAN'T	CAN'T
	36000		30	8760	75	OK	95.4	CAN'T	91.5	400	3084	156	544	4399	CAN'T	CAN'T	CAN'T	CAN'T
22	36006	33	31	8760	10	OK	92.4	9.9	85.5	85	981	60	181	1419	2165	1933	232	5.8
23	36009	34	32	4380	7.5	OK	92.0	CAN'T	84.0	73	538	60	145	859	CAN'T	1400	CAN'T	CAN'T
24	36014	36	33	8760	20	OK	91.9	3.4	88.5	102	809	81	292	1362	4341	4181	160	7.9
25	39015	37	34	4380	60	OK	95.4	CAN'T	91.5	320	2532	133	514	3691	CAN'T	8703	CAN'T	CAN'T
	39015	38	35	4380	60	OK	95.4	CAN'T	91.5	320	2532	133	514	3691	CAN'T	8703	CAN'T	CAN'T
26	39043	39	36	4380	75	OK	94.5	3.5	91.5	344	3333	156	544	4692	11341	10921	420	10.4
	39043	40	37	4380	75	OK	94.5	3.8	91.5	344	3333	156	544	4692	11378	10921	457	9.5
27	41003	41	38	4380	15	OK	93.0	CAN'T	88.0	98	864	81	218	1345	CAN'T	2397	CAN'T	CAN'T
28	42000	42	39	4380	15	OK	93.0	CAN'T	88.0	98	864	81	218	1345	CAN'T	2686	CAN'T	CAN'T
29	50001	43	40	8760	15	OK	92.4	4.4	88.0	91	887	81	218	1373	2244	2138	106	12.1
30	50004	44	41	8760	7.5	REPL	-	-	-	-	-	-	-	-	-	-	-	-
	50004	45	42	8760	7.5	DEMO	-	-	-	-	-	-	-	-	-	-	-	-
	50004	46	43	8760	7.5	DEMO	-	-	-	-	-	-	-	-	-	-	-	-
31	87018	47	44	4380	60	OK	95.4	4.4	91.5	320	2532	133	514	3691	7962	7595	367	9.2
	87018	48	45	4380	60	OK	95.4	4.4	91.5	320	2532	133	514	3691	7962	7595	367	9.2
32	91001	49	46	4380	7.5	OK	92.0	CAN'T	84.0	73	538	60	145	859	CAN'T	CAN'T	CAN'T	CAN'T

APPENDIX L

Table L-2. ECO-4 Calculation of Simple Payback Periods for Condenser Water Pumps

PLANT NO	PLANT BLDG NO	MST CH NO	MST PMP NO	OPER SCHED	DSGN POW	PUMP STATUS	NEW 100% EFF	DELTA EFF	STD MIN EFF	MOTOR UTIL REBATE	MOTOR LIST PRICE	DISCONN/ CONNECT LAB COST	REMOVE/ INSTALL LAB COST	MOTOR TOTAL COST	POW COST EXIST	POW COST NEW	MOTOR COST SAVING	MOTOR PAYBK W/ REB
				HR/YR	HP		%	%	%	$	$	$	$	$	$/YR	$/YR	$/YR	YRS
1	121	1	47	4380	20	OK	91.9	CAN'T	88.5	102	809	81	292	1362	CAN'T	3346	CAN'T	CAN'T
2	135	2	48	4380	5	REPL	-	-	-	-	-	-	-	-	-	-	-	-
	135	3	49	4380	3	DEMO	-	-	-	-	-	-	-	-	-	-	-	-
3	194	4	50	4380	15	OK	93.0	3.5	88.0	98	864	81	218	1345	2706	2604	102	12.2
5	410	6	51	4380	10	OK	91.7	5.2	85.5	79	633	60	181	1010	1400	1320	80	11.6
	410	7	52	4380	10	OK	91.7	5.2	85.5	79	633	60	181	1010	1377	1299	78	11.9
6	2805	8	53	4380	10	OK	91.7	4.2	85.5	79	633	60	181	1010	2043	1949	94	9.9
7	5764	9	54	4380	10	OK	91.7	CAN'T	85.5	79	633	60	181	1010	CAN'T	1802	CAN'T	CAN'T
8	5792	11	55	4380	20	OK	93.6	CAN'T	88.5	132	1005	81	292	1593	CAN'T	2567	CAN'T	CAN'T
9	7050	12	56	8760	20	OK	91.9	3.3	88.5	102	809	81	292	1362	4917	4740	177	7.1
	7050	13	57	8760	20	OK	91.9	4.4	88.5	102	809	81	292	1362	4948	4711	237	5.3
10	7051	14	58	8760	7.5	OK	92.0	6.0	84.0	73	538	60	145	859	1793	1676	117	6.7
	7051	15	59	0	7.5	BACKUP	-	-	-	-	-	-	-	-	-	-	-	-
13	14020	20	60	4380	10	OK	91.7	4.2	85.5	79	633	60	181	1010	1889	1802	87	10.7
14	14023	21	61	4380	10	OK	91.7	4.7	85.5	79	633	60	181	1010	1613	1530	83	11.2
15	21002	22	62	4380	10	OK	91.7	CAN'T	85.5	79	633	60	181	1010	CAN'T	2012	CAN'T	CAN'T
16	27004	23	63	4380	30	OK	94.1	CAN'T	90.2	163	1425	81	363	2165	CAN'T	4391	CAN'T	CAN'T
17	28000	24	64	4380	10	OK	91.7	7.7	85.5	79	633	60	181	1010	1327	1216	111	8.4
	28000	25	65	4380	10	OK	91.7	7.7	85.5	79	633	60	181	1010	1327	1216	111	8.4
18	29005	26	66	4380	30	OK	94.1	4.6	90.2	163	1425	81	363	2165	5433	5167	266	7.5
	29005	27	67	4380	30	OK	94.1	3.1	90.2	163	1425	81	363	2165	5343	5167	176	11.4
19	31008	28	68	4380	20	OK	93.6	5.6	88.5	132	1005	81	292	1593	CAN'T	CAN'T	CAN'T	CAN'T
20	34008	29	69	4380	30	OK	94.1	CAN'T	90.2	163	1425	81	363	2165	CAN'T	CAN'T	CAN'T	CAN'T
21	36000	30	70	8760	30	OK	94.1	2.1	90.2	163	1425	81	363	2165	CAN'T	CAN'T	CAN'T	CAN'T
	36000	31	71	8760	30	OK	94.1	2.1	90.2	163	1425	81	363	2165	CAN'T	CAN'T	CAN'T	CAN'T
	36000	32	72	8760	30	OK	94.1	2.1	90.2	163	1425	81	363	2165	CAN'T	CAN'T	CAN'T	CAN'T
	36000		73	8760	40	OK	95.0	4.0	90.2	247	1772	103	435	2677	CAN'T	CAN'T	CAN'T	CAN'T
22	36006	33	74	4380	20	OK	93.6	4.1	88.5	132	1005	81	292	1593	2512	2402	110	13.3
24	36014	36	76	8760	5	OK	91.0	7.0	82.5	52	370	60	115	628	CAN'T	CAN'T	CAN'T	CAN'T
25	39015	37	77	4380	40	OK	95.0	CAN'T	90.2	247	1772	103	435	2677	CAN'T	5705	CAN'T	CAN'T
	39015	38	78	4380	40	OK	95.0	4.0	90.2	247	1772	103	435	2677	5956	5705	251	9.7
26	39043	39	79	4380	50	OK	95.0	CAN'T	91.5	250	2066	104	486	3080	CAN'T	8254	CAN'T	CAN'T
	39043	40	80	4380	50	OK	95.0	CAN'T	91.5	250	2066	104	486	3080	CAN'T	8254	CAN'T	CAN'T
27	41003	41	81	4380	10	OK	91.7	CAN'T	85.5	79	633	60	181	1010	CAN'T	2012	CAN'T	CAN'T
28	42000	42	82	4380	15	OK	93.0	8.0	88.0	98	864	81	218	1345	2623	2397	226	5.5
30	50004	44	83	8760	10	REPL	-	-	-	-	-	-	-	-	-	-	-	-
	50004	45	84	8760	10	DEMO	-	-	-	-	-	-	-	-	-	-	-	-
	50004	46	85	8760	10	DEMO	-	-	-	-	-	-	-	-	-	-	-	-
31	87018	47	86	4380	30	OK	94.1	4.6	90.2	163	1425	81	363	2165	5196	4942	254	7.9
	87018	48	87	4380	30	OK	94.1	4.6	90.2	163	1425	81	363	2165	5196	4942	254	7.9

Appendix M: Summary of Chiller Conversion and Retrofit Options

APPENDIX M

Table M-1. Summary of Chiller Conversion and Retrofit Options (by Refrigerant).

PLANT BLDG NO	MST CH NO	COMP TYPE	REF TYPE	REF CHRG	COND TYPE	EVAP EXIST SPEC CAP	EVAP NEW SPEC CAP	REPLACE/ DEMOLISH CHILLER COST	NEED TO CHG	OPT 1 REFRIGERANT CONVERSION PRELIM ASSESS	OPT 2 DRIVELINE RETROFIT PRELIM ASSESS	OPT 3 REPLACE CHILLER PRELIM ASSESS	Eddy Current test cost	Rupt Disk & Hi Eff Purge cost	Upgrade cost	Upgrade/ Replace cost	Upgrade type
				LBS		TONS	TONS	$					$	$	$	%	
121	1	CENT, HERM	11	400	WAT	200.0	138.0	108204	YES	NO	AVAILABLE	POSSIBLE	1000	6400	85000	79	RETROFIT
7051	15	CENT, OPEN	11	600	WAT	170.0	RETAIN	-	YES	FEASIBLE	CONVERT	POSSIBLE	1000	6400	25000	-	CONV -10% CAP & EFF
7051	14	CENT, OPEN	11	600	WAT	170.0	158.0	115831	YES	FEASIBLE	CONVERT	POSSIBLE	1000	6400	25000	22	CONV -10% CAP & EFF
29005	27	CENT, HERM, 2 STG	11	880	WAT	436.0	426.6	196017	YES	NO	AVAILABLE	POSSIBLE	1000	6400	100000	51	RETROFIT
29005	26	CENT, HERM, 2 STG	11	880	WAT	512.0	426.6	196017	YES	NO	AVAILABLE	POSSIBLE	1000	6400	100000	51	RETROFIT
36000	31	CENT, OPEN	11	1400	WAT	400.0	425.7	194335	YES	FEASIBLE	CONVERT	POSSIBLE	1000	6400	29000	15	CONV -10% CAP & EFF
36000	32	CENT, HERM	11	1150	WAT	477.0	425.7	195775	YES	NO	AVAILABLE	POSSIBLE	1000	6400	110000	56	RETROFIT
36000	30	CENT, OPEN	11	1400	WAT	400.0	425.7	194335	YES	FEASIBLE	CONVERT	POSSIBLE	1000	6400	29000	15	CONV -10% CAP & EFF
36006	33	CENT, OPEN	11	900	WAT	275.0	275.0	145654	YES	FEASIBLE	CONVERT	POSSIBLE	1000	6400	25000	17	CONV -10% CAP & EFF
39015	38	CENT, HERM, 2 STG	11	1250	WAT	584.0	490.0	209308	YES	NO	AVAILABLE	POSSIBLE	1000	6400	120000	57	RETROFIT
39015	37	CENT, HERM, 2 STG	11	1250	WAT	631.0	490.0	209308	YES	NO	AVAILABLE	POSSIBLE	1000	6400	120000	57	RETROFIT
39043	40	CENT, HERM, 2 STG	11	1250	WAT	560.0	560.0	224947	YES	NO	AVAILABLE	POSSIBLE	1000	6400	120000	53	RETROFIT
39043	39	CENT, HERM, 2 STG	11	1100	WAT	560.0	560.0	224947	YES	NO	AVAILABLE	POSSIBLE	1000	6400	120000	53	RETROFIT
42000	42	CENT, HERM	11	650	WAT	209.0	188.1	122751	YES	NO	AVAILABLE	POSSIBLE	1000	6400	90000	73	RETROFIT
50004	45	CENT, HERM	11	300	WAT	125.0	DEMO	7360	YES	NO	AVAILABLE	POSSIBLE	1000	6400	85000	-	RETROFIT TO 150 TON
50004	46	CENT, OPEN	11	400	WAT	125.0	DEMO	7360	YES	FEASIBLE	CONVERT	POSSIBLE	1000	6400	25000	-	CONV -10% CAP & EFF
50004	44	CENT, HERM	11	300	WAT	125.0	306.0	150175	YES	NO	AVAILABLE	POSSIBLE	1000	6400	85000	57	RETROFIT TO 150 TON
87018	48	CENT, HERM, 2 STG	11	880	WAT	436.0	474.0	204754	YES	NO	AVAILABLE	POSSIBLE	1000	6400	100000	49	RETROFIT
87018	47	CENT, HERM, 2 STG	11	880	WAT	512.0	474.0	204754	YES	NO	AVAILABLE	POSSIBLE	1000	6400	100000	49	RETROFIT
135	2	RECIP-1	12	300	WAT	73.5	91.0	48883	YES	NOT CONSIDER	NOT CONSIDER	YES	-	500	-	-	-
194	4	CENT, HERM	12	680	WAT	228.0	107.0	72928	YES	NOT CONSIDER	AVAILABLE	POSSIBLE	-	500	-	-	NO RETROFIT
410	7	CENT, HERM	12	607	WAT	110.0	119.0	96705	YES	FEASIBLE	CONVERT	POSSIBLE	-	500	NO DATA	-	CONVERT/NO RETROFIT
410	6	CENT, HERM	12	607	WAT	110.0	119.0	96705	YES	FEASIBLE	CONVERT	POSSIBLE	NO DATA	500	NO DATA	-	CONVERT/NO RETROFIT
7050	13	CENT, HERM	12	790	WAT	210.0	153.0	115501	YES	NOT CONSIDER	AVAILABLE	POSSIBLE	-	500	-	-	NO RETROFIT
7050	12	CENT, HERM	12	790	WAT	210.0	153.0	115501	YES	NOT CONSIDER	AVAILABLE	POSSIBLE	-	500	-	-	NO RETROFIT
21002	22	CENT, HERM	12	680	WAT	215.0	240.0	133909	YES	NOT CONSIDER	AVAILABLE	POSSIBLE	-	500	-	-	NO RETROFIT
27004	23	CENT, HERM	12	1300	WAT	465.0	465.0	203561	YES	NOT CONSIDER	AVAILABLE	POSSIBLE	-	500	-	-	NO RETROFIT
28000	25	CENT, HERM	12	390	WAT	110.0	119.0	96705	YES	NOT CONSIDER	AVAILABLE	POSSIBLE	-	500	-	-	NO RETROFIT
28000	24	CENT, HERM	12	390	WAT	110.0	119.0	96705	YES	NOT CONSIDER	AVAILABLE	POSSIBLE	-	500	-	-	NO RETROFIT
41003	41	CENT, HERM	12	670	WAT	227.5	227.5	131135	YES	NOT CONSIDER	AVAILABLE	POSSIBLE	-	500	-	-	NO RETROFIT
135	3	RECIP-1	22		WAT	54.9	DEMO	1945	NO	-	-	-	-	-	-	-	-
5764	10	RECIP-2, PKG	22		AIR	71.6	DEMO	2965	NO	-	-	-	-	-	-	-	-
31008	28	SCREW	22	1350	WAT	460.0	RETAIN	-	NO	-	-	-	-	-	-	-	-
34008	29	SCREW	22	1350	WAT	460.0	RETAIN	-	NO	-	-	-	-	-	-	-	-
36009	34	RECIP-4, PKG	22	360	AIR	95.5	RETAIN	-	NO	-	-	-	-	-	-	-	-
36014	36	RECIP-1:4, HT REC	22	175	WAT	96.2	96.2	55220	NO	-	-	-	-	-	-	-	-
50001	43	RECIP-4, SPLIT	22	192	AIR	129.2	129.2	100749	NO	-	-	-	-	-	-	-	-
91001	49	RECIP-5, PKG	22	290	AIR	121.8	121.8	102060	NO	-	-	-	-	-	-	-	-
2805	8	CENT, HERM	113	400	WAT	149.8	116.0	69173	YES	NOT CONSIDER	NOT CONSIDER	YES	-	6400	-	-	-
5764	9	CENT, HERM	113	500	WAT	178.0	201.0	134139	YES	NO	AVAILABLE	POSSIBLE	1000	6400	90000	67	RETROFIT
5792	11	CENT, HERM, 2 STG	113	485	WAT	170.0	170.0	124986	YES	NO	AVAILABLE	POSSIBLE	1000	6400	85000	68	RETROFIT
14020	20	CENT, HERM, 2 STG	113	415	WAT	140.4	154.0	117289	YES	NO	AVAILABLE	POSSIBLE	1000	6400	85000	72	RETROFIT
14023	21	CENT, HERM, 2 STG	113	415	WAT	146.0	166.0	121973	YES	NO	AVAILABLE	POSSIBLE	1000	6400	85000	70	RETROFIT
36014	35	ABSORP, 1 STG	LB-1		WAT	48.0	DEMO	-	NO	-	-	-	-	-	-	-	-

APPENDIX M

Table M-2. Summary of Chiller Conversion and Retrofit Options (by Plant).

PLANT BLDG NO	MST CH NO	MFG	EQP YR	COMP TYPE	REF TYPE	REF CHRG LBS	COND TYPE	EVAP EXIST SPEC CAP TONS	EVAP NEW SPEC CAP TONS	REPLACE/ DEMOLISH CHILLER COST $	NEED TO CHG	OPT 1 REFRIGERANT CONVERSION PRELIM ASSESS	OPT 2 DRIVELINE RETROFIT PRELIM ASSESS	OPT 3 REPLACE CHILLER PRELIM ASSESS	Eddy Current test cost $	Rupt Disk & Hi Eff Purge cost $	Upgrade cost $	Upgrade/ Replace cost %	Upgrade type
121	1	CARRIER	76	CENT, HERM	11	400	WAT	200.0	138.0	108204	YES	NO	AVAILABLE	POSSIBLE	1000	6400	85000	79	RETROFIT
135	2	TRANE		RECIP-1	12	300	WAT	73.5	91.0	48883	YES	NOT CONSIDER	NOT CONSIDER	YES	-	500	-	-	-
135	3	WSTNGHS		RECIP-1	22		WAT	54.9	DEMO	1945	NO	-	-	-	-	-	-	-	-
194	4	WSTNGHS	73	CENT, HERM	12	680	WAT	228.0	107.0	72928	YES	NOT CONSIDER	AVAILABLE	POSSIBLE	-	500	-	-	NO RETROFIT
410	6	MCQUAY	84	CENT, HERM	12	607	WAT	110.0	119.0	96705	YES	FEASIBLE	CONVERT	POSSIBLE	NO DATA	500	NO DATA	-	CONVERT/NO RETROFI'
410	7	MCQUAY	84	CENT, HERM	12	607	WAT	110.0	119.0	96705	YES	FEASIBLE	CONVERT	POSSIBLE	-	500	NO DATA	-	CONVERT/NO RETROFI'
2805	8	AMER STD	61	CENT, HERM	113	400	WAT	149.8	116.0	69173	YES	NOT CONSIDER	NOT CONSIDER	YES	-	6400	-	-	-
5764	9	CARRIER		CENT, HERM	113	500	WAT	178.0	201.0	134139	YES	NO	AVAILABLE	POSSIBLE	1000	6400	90000	67	RETROFIT
5764	10			RECIP-2, PKG	22		AIR	71.6	DEMO	2965	NO	-	-	-	-	-	-	-	-
5792	11	TRANE	75	CENT, HERM, 2 STG	113	485	WAT	170.0	170.0	124986	YES	NO	AVAILABLE	POSSIBLE	1000	6400	85000	68	RETROFIT
7050	12	WSTNGHS	81	CENT, HERM	12	790	WAT	210.0	153.0	115501	YES	NOT CONSIDER	AVAILABLE	POSSIBLE	-	500	-	-	NO RETROFIT
7050	13	WSTNGHS	81	CENT, HERM	12	790	WAT	210.0	153.0	115501	YES	NOT CONSIDER	AVAILABLE	POSSIBLE	-	500	-	-	NO RETROFIT
7051	14	YORK	85	CENT, OPEN	11	600	WAT	170.0	158.0	115831	YES	FEASIBLE	CONVERT	POSSIBLE	1000	6400	25000	22	CONV -10% CAP & EFF
7051	15	YORK	85	CENT, OPEN	11	600	WAT	170.0	RETAIN	-	YES	FEASIBLE	CONVERT	POSSIBLE	1000	6400	25000	-	CONV -10% CAP & EFF
14020	20	TRANE	77	CENT, HERM, 2 STG	113	415	WAT	140.4	154.0	117289	YES	NO	AVAILABLE	POSSIBLE	1000	6400	85000	72	RETROFIT
14023	21	TRANE	77	CENT, HERM, 2 STG	113	415	WAT	146.0	166.0	121973	YES	NO	AVAILABLE	POSSIBLE	1000	6400	85000	70	RETROFIT
21002	22	WSTNGHS	71	CENT, HERM	12	680	WAT	215.0	240.0	133909	YES	NOT CONSIDER	AVAILABLE	POSSIBLE	-	500	-	-	NO RETROFIT
27004	23	WSTNGHS	72	CENT, HERM	12	1300	WAT	465.0	465.0	203561	YES	NOT CONSIDER	AVAILABLE	POSSIBLE	-	500	-	-	NO RETROFIT
28000	24	WSTNGHS	81	CENT, HERM	12	390	WAT	110.0	119.0	96705	YES	NOT CONSIDER	AVAILABLE	POSSIBLE	-	500	-	-	NO RETROFIT
28000	25	WSTNGHS	81	CENT, HERM	12	390	WAT	110.0	119.0	96705	YES	NOT CONSIDER	AVAILABLE	POSSIBLE	-	500	-	-	NO RETROFIT
29005	26	TRANE	74	CENT, HERM, 2 STG	11	880	WAT	512.0	426.6	196017	YES	NO	AVAILABLE	POSSIBLE	1000	6400	100000	51	RETROFIT
29005	27	TRANE	74	CENT, HERM, 2 STG	11	880	WAT	436.0	426.6	196017	YES	NO	AVAILABLE	POSSIBLE	1000	6400	100000	51	RETROFIT
31008	28	YORK	91	SCREW	22	1350	WAT	460.0	RETAIN	-	NO	-	-	-	-	-	-	-	-
34008	29	YORK	91	SCREW	22	1350	WAT	460.0	RETAIN	-	NO	-	-	-	-	-	-	-	-
36000	30	YORK	90	CENT, OPEN	11	1400	WAT	400.0	425.7	194335	YES	FEASIBLE	CONVERT	POSSIBLE	1000	6400	29000	15	CONV -10% CAP & EFF
36000	31	YORK	89	CENT, OPEN	11	1400	WAT	400.0	425.7	194335	YES	FEASIBLE	CONVERT	POSSIBLE	1000	6400	29000	15	CONV -10% CAP & EFF
36000	32	YORK	80	CENT, HERM	11	1150	WAT	477.0	425.7	195775	YES	NO	AVAILABLE	POSSIBLE	1000	6400	110000	56	RETROFIT
36006	33	YORK	88	CENT, OPEN	11	900	WAT	275.0	275.0	145654	YES	FEASIBLE	CONVERT	POSSIBLE	1000	6400	25000	17	CONV -10% CAP & EFF
36009	34	CARRIER		RECIP-4, PKG	22	360	AIR	95.5	RETAIN	-	NO	-	-	-	-	-	-	-	-
36014	35	TRANE	79	ABSORP, 1 STG	LB-1		WAT	48.0	DEMO	-	NO	-	-	-	-	-	-	-	-
36014	36	TRANE	79	RECIP-1:4, HT REC	22	175	WAT	96.2	96.2	55220	NO	-	-	-	-	-	-	-	-
39015	37	TRANE	76	CENT, HERM, 2 STG	11	1250	WAT	631.0	490.0	209308	YES	NO	AVAILABLE	POSSIBLE	1000	6400	120000	57	RETROFIT
39015	38	TRANE	76	CENT, HERM, 2 STG	11	1250	WAT	584.0	490.0	209308	YES	NO	AVAILABLE	POSSIBLE	1000	6400	120000	57	RETROFIT
39043	39	TRANE	77	CENT, HERM, 2 STG	11	1100	WAT	560.0	560.0	224947	YES	NO	AVAILABLE	POSSIBLE	1000	6400	120000	53	RETROFIT
39043	40	TRANE	77	CENT, HERM, 2 STG	11	1250	WAT	560.0	560.0	224947	YES	NO	AVAILABLE	POSSIBLE	1000	6400	120000	53	RETROFIT
41003	41	WSTNGHS	71	CENT, HERM	12	670	WAT	227.5	227.5	131135	YES	NOT CONSIDER	AVAILABLE	POSSIBLE	-	500	-	-	NO RETROFIT
42000	42	YORK	70	CENT, HERM	11	650	WAT	209.0	188.1	122751	YES	NO	AVAILABLE	POSSIBLE	1000	6400	90000	73	RETROFIT
50001	43	CARRIER		RECIP-4, SPLIT	22	192	AIR	129.2	129.2	100749	NO	-	-	-	-	-	-	-	-
50004	44	YORK	75	CENT, HERM	11	300	WAT	125.0	306.0	150175	YES	NO	AVAILABLE	POSSIBLE	1000	6400	85000	57	RETROFIT TO 150 TON
50004	45	YORK	75	CENT, HERM	11	300	WAT	125.0	DEMO	7360	YES	NO	AVAILABLE	POSSIBLE	1000	6400	85000	-	RETROFIT TO 150 TON
50004	46	YORK	83	CENT, OPEN	11	400	WAT	125.0	DEMO	7360	YES	FEASIBLE	CONVERT	POSSIBLE	1000	6400	25000	-	CONV -10% CAP & EFF
87018	47	TRANE	74	CENT, HERM, 2 STG	11	880	WAT	512.0	474.0	204754	YES	NO	AVAILABLE	POSSIBLE	1000	6400	100000	49	RETROFIT
87018	48	TRANE	74	CENT, HERM, 2 STG	11	880	WAT	436.0	474.0	204754	YES	NO	AVAILABLE	POSSIBLE	1000	6400	100000	49	RETROFIT
91001	49	CARRIER	85	RECIP-5, PKG	22	290	AIR	121.8	121.8	102060	NO	-	-	-	-	-	-	-	-

Appendix N: Proposed Master Plan for Chiller Upgrades

APPENDIX N

Table N-1. Recommendations for Implementing Chiller ECO's

BLDG NO		RECOMMENDATION FOR CHILLER WORK	DISPOSITION OF EXISTING CHILLER	TEST CHILLER COST $	OPTION TO REPLACE					OPTION TO CONVERT OR RETROFIT								OPTION TO RETAIN ONLY			OPTION TO ADD DRIVE		
					ENERGY COST SAVED $/YR	UTILITY REBATE $	NET COST $	NET PAYBACK W/ REB YRS	GROSS COST $	DEDUCT NEW CHILLER $	ADD UPGRADE CHILLER $	ADD MOVE CHILLER $	ENERGY COST SAVED $/YR	UTILITY REBATE $	NET COST $	NET PAYBACK W/ REB YRS	GROSS COST $	UPGRADE CHILLER COST $	REPAIR CHILLER COST $	UPGRADE BLDG COST $	ENERGY COST SAVED $/YR	DRIVE COST $	PAYBACK W/ REB YRS
5764	1.1	replace now	demolish		16619	3600	158951	9.3	165839												2341	30250	12.9
27004	1.1	replace now	demolish		27823	14760	203561	6.8	220426												4524	48247	10.7
41003	1.1	replace now	demolish		8542	3690	131135	14.9	152222												2641	29979	11.4
50001	1.1	replace now	demolish		9120	2424	139838	15.1	149281														
91001	1.1	replace now	demolish		7936	2121	145030	18.0	151322														
50004	1.2	replace, test newest	demo 2, convert/reloc the newest to 194	1000	19316	7020	164895	8.2	235237												6157	34114	5.5
				1000	89356	33615	943410	10.2	1E+06												15663	1E+05	9.1
29005	2.1	test, retrofit or replace	demolish	2000	57529	28044	392034	6.3	417258	392034	200000		57529	28044	200000	3.0	225224				4267	44208	10.4
39015	2.1	test, retrofit or replace	demolish	2000	48093	30510	418616	8.1	460257	418616	240000		48093	30510	240000	4.4	281641				5265	47879	9.1
39043	2.1	test, retrofit or replace	demolish	2000	43982	31140	449894	9.5	476195	449894	240000		43982	31140	240000	4.7	266301				6071	46660	7.7
87018	2.1	test, retrofit or replace	demolish	2000	48857	29880	409508	7.8	432399	409508	200000		48857	29880	200000	3.5	222891				5003	48112	9.6
121	2.2	test, retrofit or replace	demolish	1000	6429	2790	108204	16.4	138942	108204	85000		6429	2790	85000	12.8	115738						
42000	2.2	test, retrofit or replace	demolish	1000	11765	3522	122751	10.1	137655	122751	90000		11765	3522	90000	7.4	104904						
5792	2.3	test, retrofit or replace	demolish	1000	9040	3420	124986	13.4	135262	124986	85000		9040	3420	85000	9.0	95276						
14020	2.3	test, retrofit or replace	demolish	1000	6651	3330	117289	17.1	144166	117289	85000		6651	3330	85000	12.3	111877						
14023	2.3	test, retrofit or replace	demolish	1000	6967	3390	121973	17.0	149253	121973	85000		6967	3390	85000	11.7	112280						
7051	2.4	test, replace	convert/relocate to bldg 7050	2000	3079	3345	115831	36.5	128273	-	-		3079	3345	115831	36.5	128273						
36006	2.4	test, replace	convert/relocate to bldg 21002	1000	-504	4875	145654	-279.3	168573	-	-		-504	4875	145654	-279.3	168573				3431	34259	10.0
				16000	241888	144246	3E+06	9.8	3E+06	2265255	1310000		241888	144246	2E+06	5.9	2E+06				24037	2E+05	9.2
194	3.1	conv from 50004 or retain	demolish or retain							72928	25000	5000	2753	-	30000	10.9	44670						
7050	3.2	conv from 7051 or retain	demolish		21309	6630	231002	10.5	247939	231002	50000	10000	12290	-	60000	4.9	76937						
21002	3.2	conv from 36006 or ratain	demolish		9070	2260	133909	14.5	188516	133909	25000	5000	2293	-	30000	13.1	84607				2896	34490	11.9
					30379	8890	364911	11.7	436455	437839	100000	20000	17336	0	120000	6.9	206214				2896	34490	11.9
135	4.1	retain, upgrade chiller & rm	repair as needed															500	?	7438			
410	4.1	retain, upgrade chiller & rm	repair as needed															1000	?	10762			
2805	4.1	retain, upgrade chiller & rm	repair as needed															6400	?	14446			
28000	4.1	retain, upgrade chiller & rm	repair as needed															1000	?	10620			
36014	4.2	retain, upgrade room	repair as needed															-	?	6292			
31008	4.3	retain, upgrade chiller & rm	repair as needed															-	?	23752	5134	81557	15.9
34008	4.3	retain, upgrade chiller & rm	repair as needed															-	?	23752	4867	81557	16.8
36009	4.4	retain	repair as needed															-	?	-			
																		8900	0	97062	10001	2E+05	16.3
36000	5A	repalce 1	demolish 1, retain 2							584445	223192		21081	15450	223192	9.9	272943						
36000	5B	replace 1, convert 2	demolish 1, convert 2							584445	281192		6141	15450	281192	43.3	330943						
36000	5C	replace 3	demolish 3		25202	42012	584445	21.5	634196												8062	44224	5.5

Abbreviations and Acronyms

A	area
ARI	Air-Conditioning and Refrigeration Institute
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
CFC	chlorofluorocarbon
cfm	cubic feet per minute
DOD	Department of Defense
DOS	Disk Operating System (Microsoft Corp.)
DPW	Directorate of Public Works
DSM	demand site management
ECO	energy conservation opportunity
EDA	energy disaggragation algorithm
EEAP	Energy Engineering Analysis Program
EMCS	energy monitoring and control system
°F	degrees Fahrenheit
ft	feet
G	mass of refrigerant (pounds)
gal	gallon
HAP	Hourly Analysis Program (Carrier Corp.)
HCFC	hydrochloroflourocarbon
HFC	hydroflourocarbon
hp	horsepower
kW	kilowatt
kW/ton	kilowatt/ton of air conditioning
lb	pounds
MEIP	Model Energy Installation Program
NIST	National Institute of Science and Technology
psig	pounds per square inch gage
Q	flow rate of air (in cfm)
SERDP	Strategic Environmental Research and Development Program
TLV	threshold limit value
UCS	utility control system

UN	United Nations
USACERL	U.S. Army Construction Engineering Research Laboratories
USEPA	U.S. Environmental Protection Agency

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